SCIENTIFIC AMERICAN SUPPLEMENT No. 134

Scientific American Supplement, Vol. VI., No. 134.
Scientific American, established 1845.

NEW YORK, JULY 27, 1878.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

A MECHANICAL CURIOSITY.

By Prof. C. W. MacCord.

The accompanying cuts illustrate one of those devices for producing aggregate motions, which from the peculiarity of their action are called "differential wheels." It is well known that by combinations of this kind very high velocity ratios have been attained; but we are not aware of the existence of any single train which in that respect approaches the one here given, and the particular arrangement, of opposite pairs of bevel wheels is, we believe, new. While making no pretensions to any practical utility as it stands, it may claim a moment's attention as a curious piece of mechanism.

We have here six wheels, the numbers of the teeth in each being as follows: A, 303; B, 40; C, 250; D, 33; E, 40, and F, 12.

Now were these arranged in a train in the usual way, we should find the velocity ratio thus:

$$\frac{303}{40} \times \frac{250}{33} \times \frac{40}{12} = 191\tfrac{7}{24}.$$

That is to say, in order to cause one revolution of the last wheel of the train, it would be necessary to turn the first one $191\tfrac{7}{24}$ times. Whereas, in the arrangement here shown, in order to turn C once, we must turn F no less than 262,500 times.

The contrast will perhaps appear more striking if we suppose three trains of each kind to be consecutively connected, the last wheel of each train being made to turn the first one of the next. Let us further imagine that the first wheel of each of these triple trains is set in motion by an engine running ceaselessly at the rate of 100 revolutions per minute.

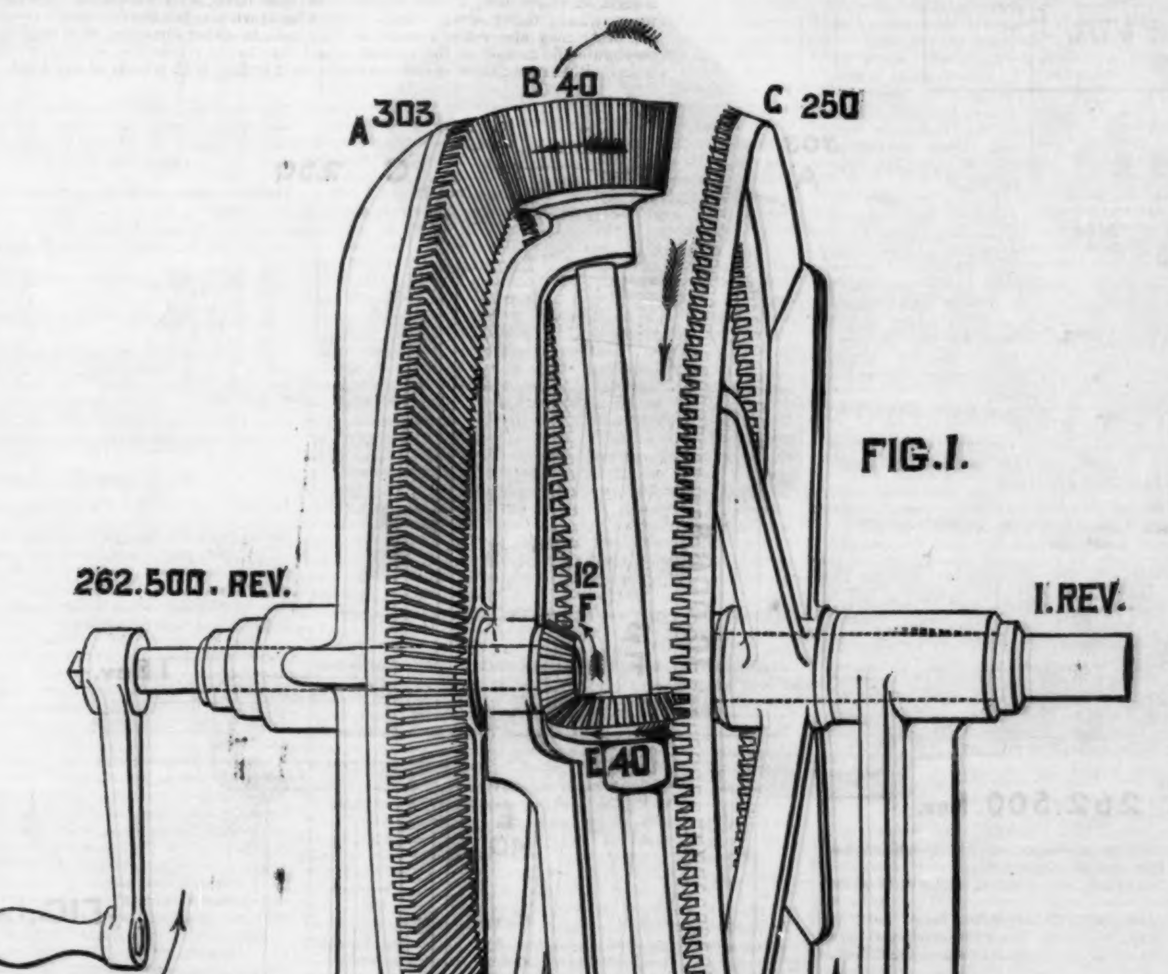
Then the last wheel in the system of eighteen, arranged as at first supposed, will turn between 7 and 8 times in a year. But the result will be somewhat different with the three trains of wheels disposed as in the cut, the last one of which will have very little more than completed its first revolution at the end of 344 millions of years.

Those who are familiar with the operation of epicyclic trains, we think, will find no difficulty in tracing, by the aid of Fig. 1 and Fig. 1a alone, the action of the various wheels upon each other, by which this result is accomplished. But to those who are not, this action may be rather obscure; and they may find the other figures of some assistance.

In Fig. 2 we have two spur-wheels, M and N; M turning on a stud, S, fixed in the frame, O. This stud, S, is also the center of motion of the movable arm, P, in which is fixed the stud, R, on which the wheel, N, is centered. In the arm are two holes, *i*, *l*; a hole in N corresponding to the former, one in O to the latter; and *e* is a hole in M, a corresponding one being made in O.

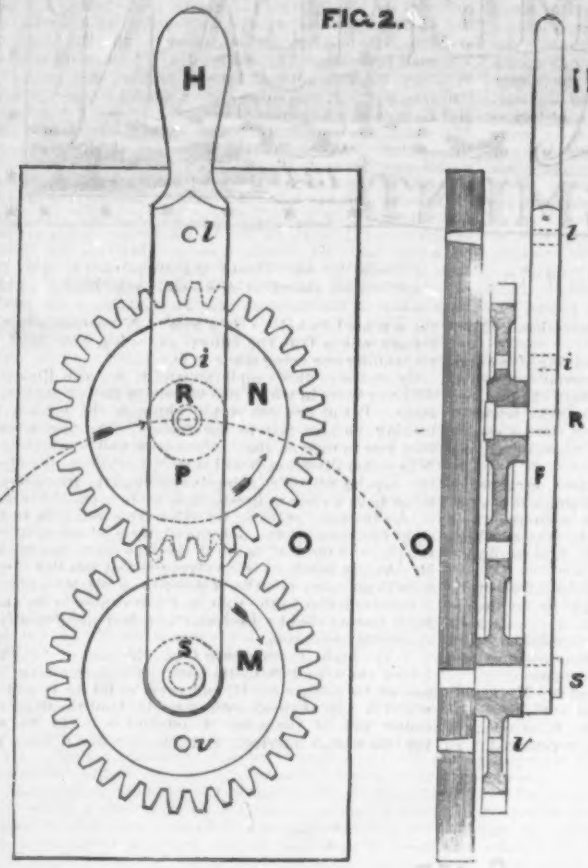
By means of this simple apparatus we can illustrate the different ways in which one wheel can impart motion to another. Let us first put a pin through the holes at *l*, thus locking the arm fast to the frame. The two wheels are then free to turn on the *fixed* studs, R and S; and if we turn N in either direction, it will turn M in the opposite direction, the angular velocities being inversely as the diameters. Now let us have a clear understanding as to terms. We say that N, for instance, turns on its *axis*. This axis is an imaginary right line, passing through the center, and perpendicular to the plane of motion; being in fact the *center line* of the stud R. And in turning, or revolving, about this line, let it be noted that every point in N describes a circle, whose plane is perpendicular to the axis, and the center is in the axis. Such motion about a *fixed* axis is called indifferently either *revolution* or *rotation*.

Next remove the pin from *l*, and by means of the holes at *i* lock the wheel N to the arm. The latter may then be moved by the handle, H, and every point in it and in the wheel N will then describe a circle about the fixed axis, or center line, of the wheel M and stud S. But the teeth of the two wheels interlock, and consequently M must revolve



NEW FORM OF DIFFERENTIAL WHEELS.—By Prof. C. W. MacCord.

FIG. 2.



about the same axis, *in the same direction and with the same angular velocity*, whatever the relative diameters of the two wheels. In this case there is no rotation of N around its own axis; everything turns about the axis of M, and this motion of N is properly called a *revolution* around M. We will now remove the pin altogether. This leaves us free to move the arm as before, causing N to revolve around M, and also to turn it at the same time around its own axis in either direction, and at any speed, the motions of revolution and of rotation being entirely independent of each other. But the interlocking of the teeth transmits both these motions to M, which thus receives what is called an *aggregate* motion. If we carry P around to the right, as indicated by the large arrow, that movement *tends* to turn M in the same direction and with the same angular velocity. If at the same time we turn N on its own axis in the same direction, that movement will *tend* to turn M in the opposite direction, with an angular velocity dependent not only on that of N but on the ratio of the diameters. But it is clear that whatever this angular velocity may be, it goes to diminish the forward motion of M due to that of the crank; if the two be equal, M will stand still; if N by rotating would turn M backward faster than the crank arm would carry it forward, then M will turn backward; if not, then M will still go forward, but less rapidly than the crank. Finally, put the pin in the holes at *v*, locking M to the frame. Then N is free to revolve around M, but in doing so it will be compelled to rotate around its own axis, with an angular velocity which will be to that of the revolution in the inverse ratio of their diameters. Thus, if the wheels be of equal size, N will rotate once on its own axis while revolving once around M; if M be twice as large as N, there will be two rotations in each revolution, and so on.

In these latter cases it will be observed that the *axis* of N revolves about that of M; and these two lines are always parallel to each other, simply because we used spur-wheels. But that is not necessary: one right line may revolve around another one fixed in space, just as well if the two intersect, or if they lie in different planes, as if they are parallel. And these two lines may be the axes of two wheels, in either case; if they intersect, we shall have bevel wheels; if they are not in the same plane we may have either screw wheels or skew-bevel wheels; but the one which revolves around the axis of the other may also rotate around its own axis, in either direction, thus tending either to retard or to accelerate the motion of the central wheel due to the revolution, so that we may construct epicyclic trains, either cumulative or differential in their action, with wheels of any kind.

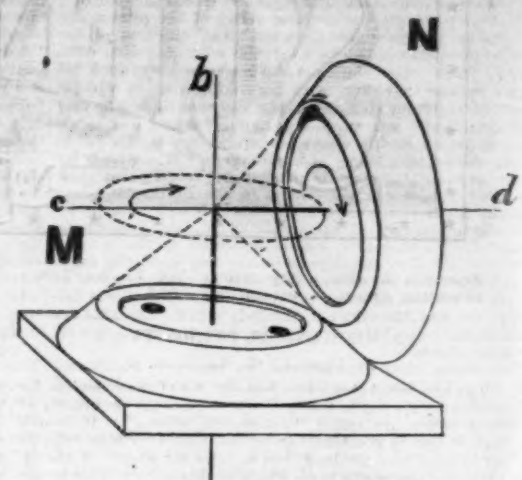


FIG. 3.

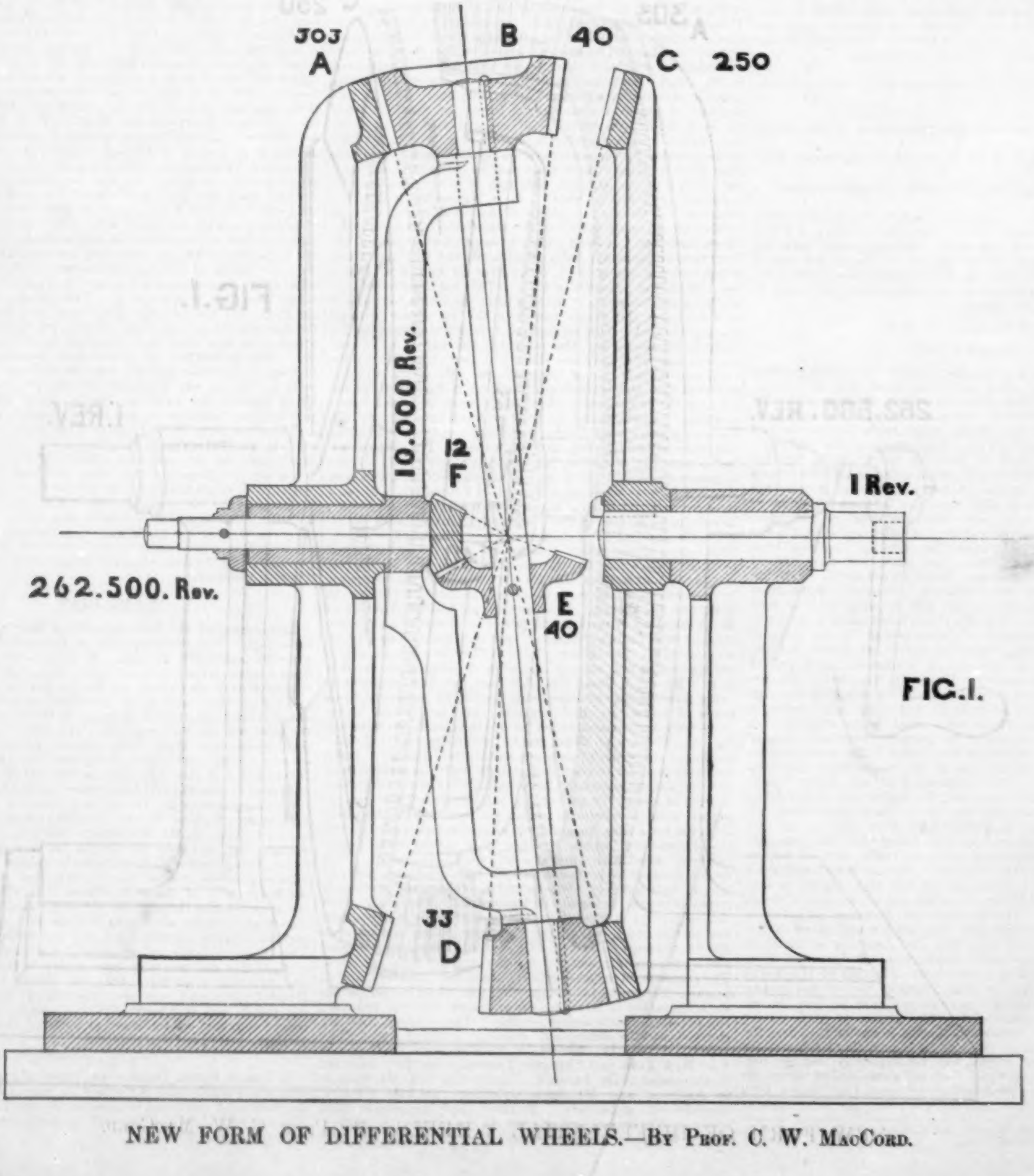


FIG. 1.

NEW FORM OF DIFFERENTIAL WHEELS.—BY PROF. C. W. MACCORD.

The perspective sketch, Fig. 3, shows this in the case of a pair of miter wheels, the common vertex of the pitch cones being at the intersection of the axes. The question of the number of rotations made by a movable wheel in rolling once round a fixed one of the same size has been very much befogged by various writers with hazy notions as to what is meant by revolving round an axis. But even those who may have been misled into supposing that any wheel ever made two rotations under the above conditions can hardly fail to be undeceived by a glance at this diagram. The wheels being of the same size, it needs no argument to show that while the axis *c d* describes one circuit in the horizontal plane around the vertical axis, *a b*, the wheel N will measure its own circumference off upon that of M, and rotate once around the moving axis, *c d*, as indicated by the arrows. Evidently this does not depend in any way upon the angle included between the axes, which may be made as acute as we please without affecting the result; and when this is carried to the limit the vertex is infinitely remote, the axes are parallel, the cones become cylinders, and the bevel wheels are spur wheels.

This being clearly understood, we return to Fig. 1 and Fig. 1*a*. The wheel A is fixed, and the wheels B, D and E are secured to one shaft, which is carried by an arm whose tubular journal is free to revolve, its horizontal axis being the same as that of the wheels A and C. Within this hollow journal the axle of F turns, and this being set in motion, F acts through E upon B and D; the rotation of B causes it to travel round A, and also compels D to revolve around C and E around F.

The velocity ratio may be most readily ascertained by first considering what will occur during one revolution of the carrier arm. This revolution will cause B to rotate on its axis $\frac{303}{40}$ times. But each rotation of D will cause C to rotate, if not otherwise acted on, $\frac{33}{250}$ times. Combining these factors, we see that C would be made to rotate, by the *rotatory* motion of D due to one revolution of the carrier arm, $\frac{303}{40} \times \frac{33}{250} = \frac{9999}{10000}$ times. But it will be observed that if D did not rotate at all, each revolution of the carrier arm would cause C to rotate once, and that in a direction *opposite* to that in which the rotation of D tends to drive it. From the above result we must therefore subtract unity, which leaves $\frac{9999}{10000} - 1 = -\frac{1}{10000}$, as the fraction of a turn made by C. In other words, the carrier arm must make 10,000 revolutions in order to turn C once round—the negative sign, obviously, indicating merely that if the arm be turned in one direction, the motion of C will be in the other.

But now one rotation of E will cause F to rotate $\frac{40}{12}$ times, and E rotates $\frac{303}{40}$ times during one revolution of the carrier arm. This rotation of E alone, therefore, will cause F to turn $\frac{303}{40} \times \frac{40}{12} = 25\frac{1}{4}$ times; but with this pair we have a cumulative instead of a differential action, the axial rotation of E tending to increase, not to retard, the velocity of F due to the revolution of E round it. Adding unity, then, we have the result that in one revolution of the carrier arm, F turns $26\frac{1}{4}$ times. It must, therefore, during the 10,000 revolutions required to produce one rotation of the last wheel, C, turn, as stated, 262,500 times.

TRAMWAYS.*

TRAMWAYS are now a recognized mode of working urban and suburban traffic; they have made their way into public favor in the face of persistent opposition, and instead of being removed will probably ultimately become the only public means of conveyance on the main roads leading to and between our principal towns. Tramways are not railways, it is true, but Mr. Clark is justified in protesting against tramway-engineering being regarded as but an humble branch of the profession. On the contrary, tramways require the exercise of the highest skill that can be found, for just as railways in their infancy were often failures, so tramways have arrived at the present degree of efficiency after a series of blunders. They cost more for working expenses than railways, and they earn more per mile, but they are, of course, cheaper to construct. Such a work as Mr. Clark has placed before us was much wanted. Sooner or later steam or some other mechanical power will be employed to haul the "ponderous cars," for Mr. Clark is not alone in the opinion that the employment of horse-power in the work of starting and dragging, often on severe gradients, heavily-loaded tramcars is an element of barbarism much out of place in a civilized country. It may be true that steam-cars or the locomotives at present devised for drawing the cars are not all that could be desired; but it is, nevertheless, a fact that where they have been tried under suitable conditions, they have answered the purpose very well, considering that, as yet, they stand very much in the same position that Stephenson's Rocket did to the magnificent machines that came after it. The withdrawal of the steam "dummies" (a dummy is a steam-car, the engine and boiler being carried on the same platform as the passengers) from the Market Street route in Philadelphia gave rise to the idea that steam was a failure; the fact being that the company had not enough dummies to work the traffic, and so, having to keep as many men to look after three as would suffice for twenty, and having, moreover, to run those three in conjunction with cars drawn by horses, the advantages of steam were discounted. The dummies are, however, objected to, because in summer especially they are hot and smell badly, and it is consequently seen that the direction in which to look for a more successful application of steam to street traffic is in the shape of a locomotive like that of Hughes or Merryweather. But in that direction we are met by two difficulties. To employ a separate motor is to lose the adhesion of the car itself, and if the engine is made heavy enough to provide sufficient adhesion to enable it to drag the car up any gradient on the road, it is probably too heavy for the permanent way, which will consequently require continual and costly repairs. The self-contained or steam-car has, therefore, one great advantage over that drawn by a locomotive—that it is best adapted for the tramways at present laid; but there is no doubt that when once Parliamentary sanction is obtained for the employment of steam or other mechanical power without unnecessary restrictions, the demand for motors will be met by the invention of the engine required. Mr. Clark divides his work into five parts, and presents us with an enormous collection of facts, carefully arranged for the guidance and instruction of the engineer and the capitalist. His first part is a history of the origin and progress of tramways, from the early timber rails employed 200 years ago, to the elaborate arrangements of rails, ties, and sleepers adopted in this country and abroad. The wooden tram-rails were occasionally plated with wrought iron, but in 1767 the Coalbrook Dale Company determined to protect their oak rails with cast-iron, because the price of iron being very low, and not wishing to blow out the furnaces, they were in a difficulty as to stocking. Accordingly, they cast the iron into pigs 5 ft. long, 4 ins. wide, and $1\frac{1}{4}$ in. thick, with three holes, through which they were fastened to the timber rails. By this means they made the iron help to pay the interest by reducing the cost of repairs, and the pigs were there at any time when wanted. The modern tramway was first employed in the United States, where, owing to the badness of the roads and the long distances to be traversed, a rapid means of transport was the first necessity to the pursuit of business. The New York and Harlem line was opened in 1832, but did not meet with favor, and was for a time suppressed. In 1852, however, M. Loubat, a French engineer, laid down a tramway in New York, consisting of rolled-iron rails placed upon wooden sleepers. The rails had a wide groove in the upper surface, and were similar to those afterward laid down by the same engineer in Paris. Tramways had by this time become so essential to New York that the objections made to them by the proprietors of other vehicles were disregarded, and they multiplied rapidly, not only in the Empire City, which owes most of its amazingly rapid development to them, but in the principal towns of the States.

Mr. Clark speaks of the "fearless manner" in which the rails were proportioned, but they were tolerated because the tramways were of more importance than the comparatively few vehicles which traversed the streets. In 1856 a Mr. C. L. Light, an English engineer, laid an improved tramway in Boston, in which the depth of the groove was only $\frac{3}{4}$ in., while the inner side of the rail formed a flat slope. The Philadelphia step-rail was also an improvement, dispensing with a groove altogether, but having a ridge at one side against which the wheel-flanges ran; it answered its purpose well, and is still in use in that city, while a similar pattern has been adopted for New York. In fact, the step-rail may be said to be that most generally used in the United States. When introduced to England by Mr. Train it was speedily condemned, and the lines laid by him at Birkenhead and the Potteries were only saved from suppression by the substitution of flat-grooved rails of the kind with which we have since become familiar. The modern practices, for there are several methods still, as it were, under trial, are fully explained in Mr. Clark's book, and the numerous woodcuts and lithographic plates render his work of great value. The present practice of tramway construction forms the Second Part of the book, and the many tables of cost and working expenditure which he has inserted in Part Three will be studied with attention by the municipal authorities and capitalists. Part Four introduces us to what may be termed the mechanical portion of the subject, although it is confined to a description of tramway cars. It is impossible within the limits we can devote to a notice of this book to give even an outline of the many details of the numerous cars which Mr. Clark describes. It must suffice to say that examples of the best constructions are fully illustrated, and that the latest improvements are noticed, down even to Eade's reversible car, which was patented in 1877. This car is swiveled centrally on the underframe, so that after the locking apparatus is unfastened, the driver can turn the car round without leaving his seat. This arrangement avoids the necessity for shifting the horses and the pole, and the car is, of course, constructed with only one door and two staircases to the roof, one on each side of the platform. Mr. Clark says it is reported that the reversible car effects a saving of 30 per cent. in the horse-power required—a stud of eight horses working it as efficiently as twelve work the ordinary car. Eade's car is unusually light, weighing empty only 34 cwt., while one wheel on each axle runs loose. The alleged saving in power is, of course, due to the lightness of the car, not to its reversibility. It is in use on the Salford tramways. The Fifth Part, Mechanical Power on Tramways, will be of most interest to the great majority of readers, for the further development of the tramway system depends almost entirely on the application of mechanical power for their working. The report of the Select Committee issued recently will probably give a stimulus to the introduction of steam and compressed air motors, though they will still be hampered by restrictions which seem to those familiar with engines to border on the absurd. Mr. Clark, in his historical sketch of the application of mechanical power to tramway cars, commences with Latta's "dummy" put on the Cincinnati Tramway in 1850. The earlier efforts of Trevithick and others are ignored as not, strictly speaking, belonging to the subject. Mr. L. J. Todd was, however, the first engineer to bring forward any practical designs for the employment on roads of steam-propelled tramcars; and we believe his engines were the earliest which met all the conditions imposed, viz., the absence of noise, smoke, and steam, with the possession of the power of stopping and starting quickly. About the same time Dr. Lamm experimented with an ammoniacal-gas car, and demonstrated the practicability of the invention; but the necessity for preventing all escape of the gas, together with its chemical action on iron, led Dr. Lamm to abandon for a time his ammonia engine in favor of the fireless locomotive, which consists of a strong well-clothed reservoir filled with water at a very high temperature. The fireless locomotive is running on the line, about six miles in length, between New Orleans and Carrolton, the stationary steam-generator being at the latter place. The reservoir of the locomotive is filled with cold or preferably warm water, and then is connected to the Carrolton boiler, and steam of 200 lbs. pressure forced in. The water is thus quickly heated and a pressure of about 180 lbs. per square inch obtained. The contents of the reservoir are about 60 cubic feet, and in practice it is found to contain sufficient steam to run the car from Carrolton to New Orleans and back without reducing the pressure much below 50 lbs. The exhaust was discharged into the atmosphere, making clouds of moist white vapor. Two other fireless locomotives were tried on the East New York and Canarsie Tramway, but they were not so successful as Dr. Lamm's. About this time Mr. Baxter, in America, and Mr. John Grantham, in this country, brought out steam-cars. Baxter's had an engine with compound cylinders and carried 54 passengers; and Grantham's, which was the first steam-car actually built and tried in England, had a boiler on each side of the body, in the center of the length, with the engine underneath. It carried 44 passengers and worked well enough on the trial line at Brompton, but failed when tested on the line between Vauxhall Bridge and Victoria Station. It was removed to Wantage, but was unfitted for the inclines and curves of that tramway. It was subsequently altered by the advice of Mr. E. Woods, who replaced the two separated boilers by one, which was completely boxed in, and served to divide the car into portions, leaving a passage at one side communicating between the first and second class divisions. One pair of the wheels was used for driving and one wheel of the other pair ran loose, for ease in passing curves. It accommodated 60 passengers, and its estimated cost, from experience of its work on the Wantage line, was less than 4d. a mile run. Mr. Woods recommended that the Grantham car, built for the Vienna tramways, should have the boiler and engine placed at one end, while instead of the loose wheel on the undriven axle, he proposed a four-wheel bogie. This car was fairly successful, but the boiler, though a rapid generator, was too limited in water room, and required very skillful management. On a good road the working speed is from 10 to 12 miles per hour. In 1874 Mr. Loftus Perkins designed a tramway locomotive for a Belgian company. It was worked at a pressure of 500 lbs. on the square inch, and had compound engines, the high-pressure cylinder being single-acting. The steam exhausted into an air-surface condenser, consisting of a number of copper tubes. The boiler was of bent iron tubes, $2\frac{1}{4}$ ins. diameter (inside) and $\frac{3}{8}$ in. thick, tested to 2,500 lbs. on the square inch. Coke was the fuel, the draught being due to the height of chimney alone. The speed of the crank shaft was reduced by toothed gearing in the ratio of four to one, and the motion was taken off the second shaft to the wheels of coupling-rods. At the commencement of its working life this locomotive was reported to be perfect—"no smoke, no escape of steam into the atmosphere, no noise, no feeding of water during the trip, nor even, if needful, for several days." The high pressure, however, rendered it very difficult to maintain the joints, and after altering the engine, the Belgian authorities concluded to take it to pieces and sell it as old metal. Mr. Perkins has, however, recently improved his design, and Mr. Clark says at the conclusion of an elaborate description, accompanied by an excellent lithograph, that "it is anticipated that very economical results of performance will be obtained by the use of this locomotive. The Société Métallurgique et Charbonnière of Belgium constructed a tramway locomotive in 1875, with a Brotherhood three-cylinder engine and a Bellville "inexplodable boiler," the speed being reduced by spur gear. It resembles an omnibus in appearance, and altogether is scarcely likely to become the motor of the future. Of the numerous devices that have been tried we can only allude to Francq's improved hot-water locomotive, in which the steam from the reservoir is admitted to an intermediate chamber, where it is maintained at a fixed pressure; to Todd's hot-water steam-car, in which the reservoir and machinery are carried beneath the floor; to MM. Bède & Co.'s hot-water steam-car, which has been running regularly and successfully in Belgium, and to the engines of Merryweather, Hughes, H. P. Holt, Ransom, and Baldwin, the two former of which are well known from descriptions already published. Most of the designs are illustrated by diagrams, and some have large lithographic plates devoted to them. It will be understood from what we have said that Mr. Clark's work is a perfect treasury of tramway facts, but it is even more than that, because some of his chapters are occupied with dissertations on the principles of tramway construction and working, in which points apt to be overlooked by inventors are carefully considered. Cars, he thinks, should be constructed on double bogies, or, still better, on radiating axles, and they should have a longer wheel base than is now usual. The results obtained with the Paris omnibus car, Mr. Eade's car, and Mr. Cleminson's flexible wheel-base car, point to the desirability of starting afresh with new ideas, and recasting the design of the tramcar. The production of a noiseless, vaporless, smokeless, and handy machine will not come from those who too slavishly follow the old lines; but of the present devices Mr. Clark awards the palm, as first in order and foremost in practical performance, to the Merryweather, which in Paris and in other parts of the Continent has been doing effective service on the tramways, "causeless of annoyance or hinderance to the ordinary traffic of the streets." It is too much to hope that this work will lead to the prompt withdrawal of all vexatious restrictions on the use of mechanical power for propelling street cars; but while it places a vast amount of practical information before the engineer, it serves to enlighten those who may ultimately have to decide whether a mechanical-power tramway shall or shall not be allowed in the districts over which they have control.—*English Mechanic.*

* Tramways, their Construction and Working. By D. K. Clark, C. E. London: Crosby Lockwood & Co.

FLOUR DUST.

IN speaking of the late explosion at Minneapolis the *Mill-Stone* says: "On the south side of the mill there were two rows of buhrs, ten in each. A strong current of air was drawn through the conveyor boxes connected therewith, and this current of air took up all the fine particles of flour dust, and the moisture and gases generated in grinding, and discharged them into two dust rooms in the story below, where the dust was allowed to settle. The daily deposit in these dust rooms was about 3,000 pounds, which was removed every morning, and consequently the dust rooms were half full or more of this fine dust, and the air in the dust rooms and conveyor boxes and blast tubes leading thereto was also fully charged with it. Owing to a choke-up in some of the feed spouts leading to the middlings stones above, one or more of them, in Mr. Christian's opinion, must have been running dry, and thus set fire to the dust in the conveyor boxes, being thence instantaneously communicated to the dust rooms, which were blown open, and the fire spread in the lower story of the mill, whence it rapidly ascended into the upper stories through the elevator trunks, etc. The fine dust floating in the air throughout the mill instantly ignited, and the explosion which shattered the walls was the result. This theory is borne out by several circumstances which go to show that the mill was first on fire in the basement, and the explosion must have followed almost instantaneously. Four of the bodies recovered were found in the vicinity of the pump, and it appears that an alarm of fire had been turned into the engine-house of steamer No. 1, in the near vicinity, just before the explosion."

A LARGE STEEL INGOT.—An ingot of steel weighing 90 tons was recently cast at Creusot so successfully that preparations are being made to produce one of 125 tons weight. The largest ingots hitherto cast in the works of Krupp, at Essen, weighed 50 tons.

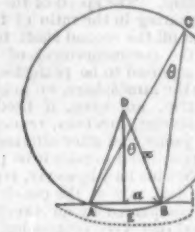
THE GROSSER KURFÜRST.

We present an illustration of this unfortunate German ironclad war-ship, the loss of which, accompanied by that of more than 280 men, by collision with the Admiral's flagship König Wilhelm, in sight of Folkestone, Eng., lately took place. The Grosser Kurfürst was a turret-ship carrying four ten-inch Krupp rifled guns in her two turrets, and two smaller guns on her deck; she was not nearly so large as the König Wilhelm, the extreme displacement being 6,663 tons. Her turret-plates were ten inches thick, and the armor of her sides from seven to nine inches. She was constructed at the Prussian Government Dockyard of Wilhelmshafen, and was launched about three years ago. A diver has made an examination, and found that the vessel is in two distinct halves, one half lying keel uppermost and the other half having a mast standing. The diver thinks the ship received a twist when her boilers exploded. He says that the side of the ship is torn away for about twenty feet, but that the depth of the breach is not more than three or four feet at its widest part.—*Illustrated London News.*

THE RUDDER POWER OF STEAMSHIPS.*

By Robert Clark, Esq., Imperial College of Engineering, Tokio, Japan.

Steamships after being equipped are usually subjected to certain trials to ascertain the diameter of the smallest circle in which they will turn round with the rudder in any given position. These experiments are carried on by means



of certain battens and straight edges being brought into line with some object previously thrown overboard in the wake of a vessel. This system of experiment is open to several objections which I shall endeavor to point out.

First.—By means of a batten, an angle cannot be measured with accuracy, and should the error in the observation amount to not more than a degree, the error in the diameter of the circle would be very material.

Second.—In taking sights by means of battens at least two men are required, and the vessel being in motion, error is liable to be engendered by the sights not being entirely simultaneous.

Third.—The buoy or floating object is liable to move from its first position in the wake of the vessel.

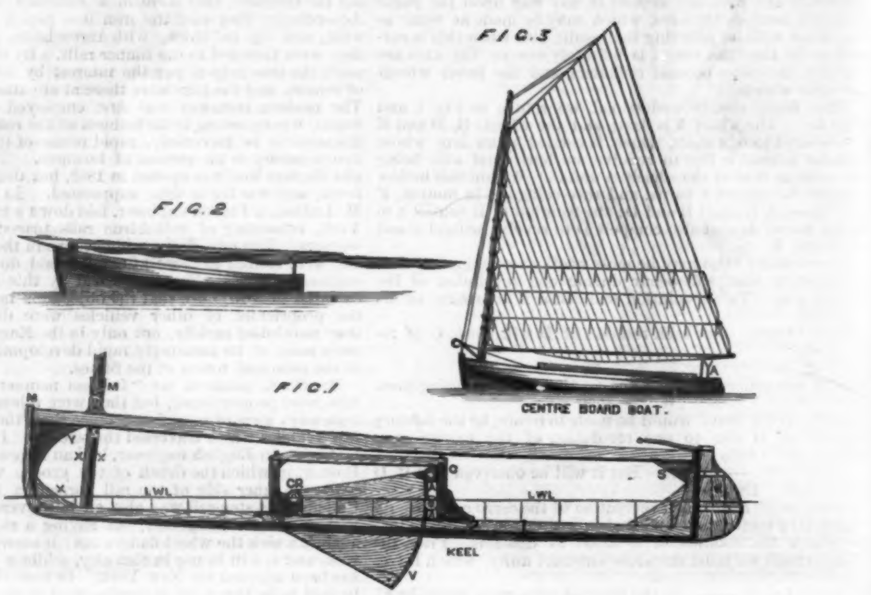
These objections may be obviated by pulling a boat into and retaining it in the wake of the ship, and from the boat observing with a sextant the angle subtended at the eye by the two extreme masts of the vessel. This angle, as shown in the annexed sketch, is constant, and sufficient time is afforded for making the observation with accuracy.

The foregoing observation having been made, at a certain preconcerted signal the angle of the rudder may be changed, and a fresh observation made from the boat, which may be repeated as often as may be deemed necessary. The diameters of the different circles can then be easily calculated from the data at hand; for representing the length between the extreme masts by $2a$, and denoting the radius of the required circle by x, we have sin. of one of the angles just obtained equal to $\frac{a}{x}$ (x being the radius of the circle the ship described, from which was taken the corresponding angle). Suppose A and B (see diagram) to be the two masts of a ship passing round a circle A B C, we can reasonably assume the straight line A B to be a chord of the circle A B C; hence the angle subtended at C is constant and equal to the angle E D B, which we denote by θ, and $\sin\theta = \frac{EB}{BD} = \frac{a}{x}$; whence $x = \frac{a}{\sin\theta}$, *i.e.*, we have the radius of the required circle expressed in terms of the known distance between the masts and the known angle. For example, take E B = 50 feet, and suppose $\theta = 5°$; then $x = \frac{50}{\sin 5°} = \frac{50}{\cdot 0871557} = 579{\cdot}42$ feet, and supposing the rudder to be altered so that the angle subtended at C or θ shall be $5°\ 1'$, then as before,

$$x = \frac{50}{\sin 5°\ 1'} = \frac{50}{\cdot 0874455} = 571{\cdot}78 \text{ feet.}$$

Thus, a difference of 1 min., which is easily distinguishable with a sextant, makes the difference between the diameters of these two circles = 15·28 feet, which is certainly considerable.—*Marine Engineering News.*

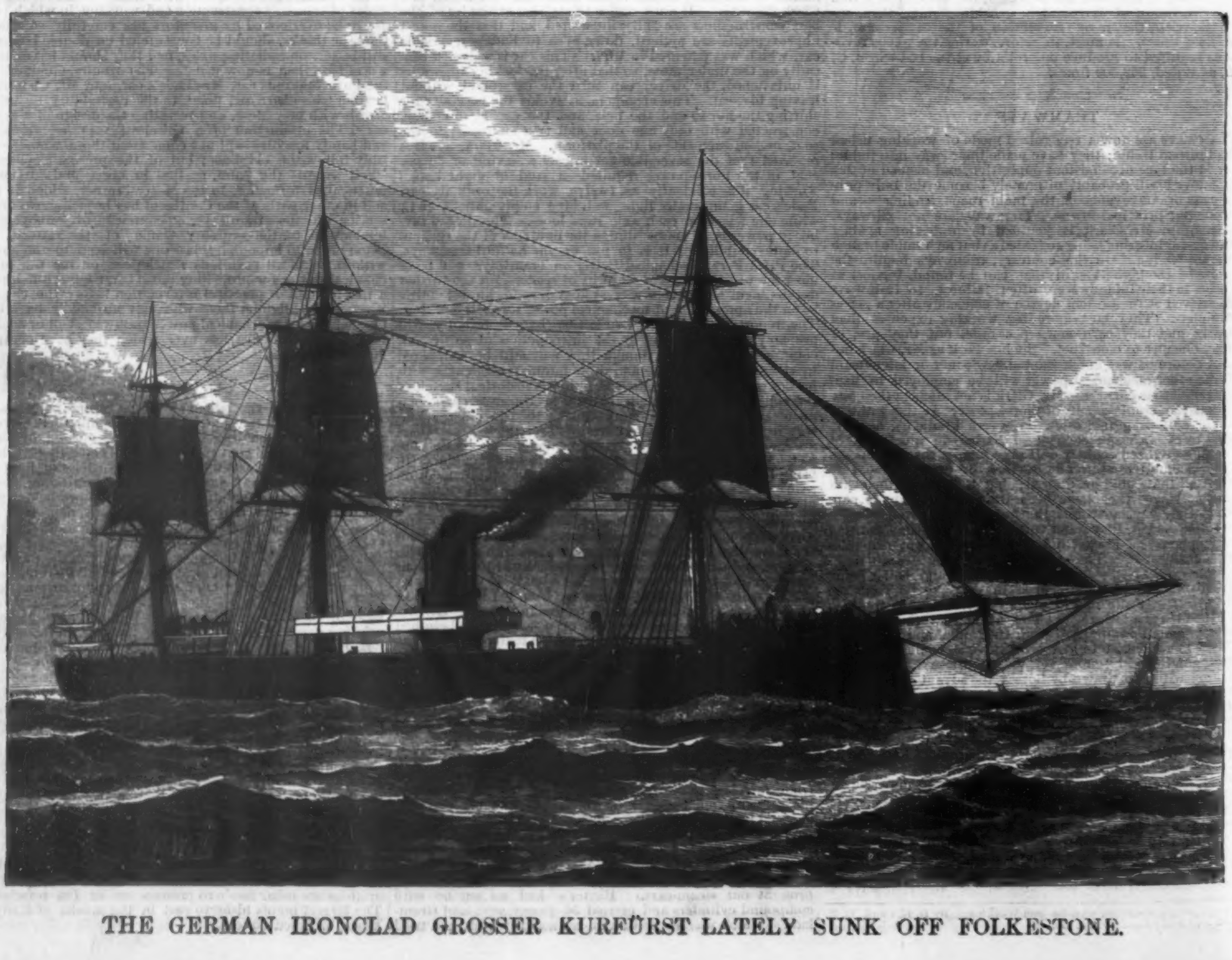
* Read before the Institution of Naval Architects.



ROLLER CENTER BOARD AND HINGED MAST.

SAIL BOAT WITH ROLLER CENTER BOARD.

The center board, H, works upon rollers, A A, which is a much safer plan than the ordinary mode of fitting. There is a mast joint at M, by which the sail can be lowered as in Fig. 2. This arrangement will be very handy for center-board boats, as it relieves the yacht of the mast weight. In a squall the mast is quickly lowered.



THE GERMAN IRONCLAD GROSSER KURFÜRST LATELY SUNK OFF FOLKESTONE.

FIG. 1.

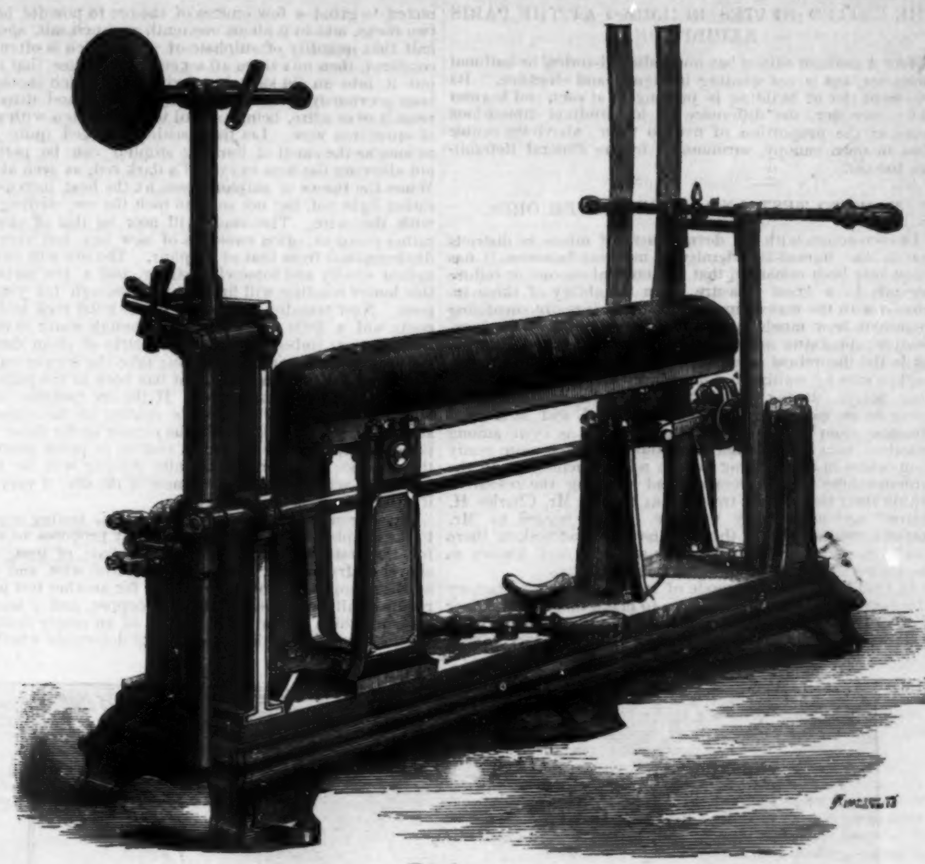


FIG. 2.

FIG. 3.

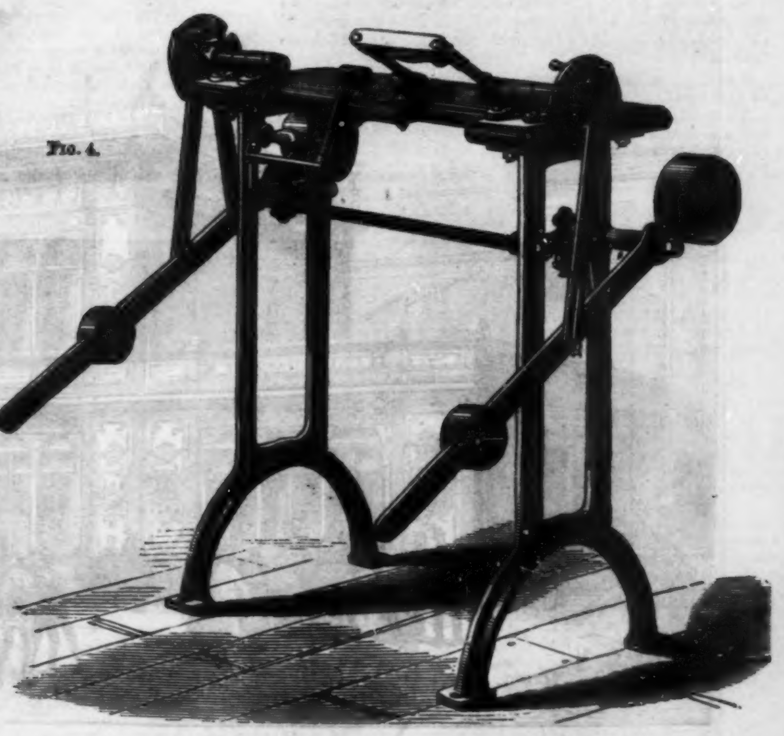


FIG. 4.

THERAPEUTIC MACHINERY, AT THE PARIS EXHIBITION.

THERAPEUTIC MACHINERY AT THE PARIS EXHIBITION.

ONE of the novelties which excited considerable interest in the Machinery Hall of the Centennial Exhibition at Philadelphia was the series of therapeutic machinery exhibited by Dr. G. Zander, of Stockholm. In the Champs de Mars this collection, with some modifications, is again brought together, and it will no doubt attract an equal share of attention. The whole number of machines is 42, but only 18 are exhibited. Dr. Zander is the director of the so-called Mechanico-Therapeutic Institution of Stockholm, and his process consists in the special exercise of various muscles, and also in mechanical operations on portions of the body.

The institution differs from ordinary gymnasiums, not only in its completeness, but also by the introduction of mechanical appliances by which every desired kind of exercises can be concentrated upon any series of given muscles, to a degree entirely under the control of the operator or the patient, and this is an important feature in the system, as Dr. Zander claims that it is necessary to determine, for each class of ailment which he aspires to treat, the exact degree of work which should be thrown upon the muscles, as well as the precise duration of the work. Another feature is that in each machine the amount of work to be performed by the patient can be increased or diminished at will, so that the action of the muscles can be gradually stimulated.

The institution of Dr. Zander is on quite an extensive scale, and contains 77 machines, of which 18 are used for developing the muscles of the arms, 20 for those of the legs, 11 for the active movement of the body, and 28 for its passive movement. The whole of these machines are actuated by a 6-horse power engine. The establishment was opened in 1864, and the number of patients treated since that time has been upward of 2,000. There are several similar establishments, not on so large a scale, in Russia and Norway.

To convey an idea of the nature of these machines we publish in the above illustrations representations of four of the series. Fig. 1 is a view of an instrument for treating the muscles of the ankle. It consists of a sole-plate, to which the foot is secured by means of two sliding stops working on a screw, and adjusted by a small lever. This sole-plate is mounted on a bent axle, the lower end of which is pivoted on to the frame of the machine, and the upper end is connected with a sliding-bar that passes through the spindle of a flywheel on the top of the frame. When this wheel is caused to revolve the axle and sole-plate revolve with it, with an angularity of movement more or less marked according to the distance of the upper bearing of the axle from the center of the wheel spindle. The person operated upon sits in a chair in front of the instrument with his foot secured to the sole-plate as described.

Fig. 2 is a compound machine for acting on the muscles of the legs, and for friction or percussion on any part of the body. The former consists of a horizontal padded cushion, hinged at one extremity and resting on cams at the other, to which a very rapid rotary motion is imparted in such a way that the cushion is thrown into a state of intense vibration. The restorative action of this part of the machine is very remarkable. The other part of the apparatus consists of a vertical spindle sliding in long bearings, and capable of being locked at any height by the set screws shown. A very rapid reciprocating motion is imparted to this spindle by means of the small connecting rod shown on the left-hand side of the engraving. The pad at the top of the spindle is caused to move to and fro with about 600 strokes per minute. This apparatus is especially intended for application to the back and shoulder, and different shaped pads are employed according to circumstances. Fig. 3 is a machine consisting of a saddle mounted on a shaft, somewhat like that shown in Fig. 1, the lower end of the shaft working in a socket on a sliding bar to regulate the motion. The patient, sitting astride of the saddle, is subjected to the influence of a more or less pronounced rolling movement, which brings the muscles of the trunk into action. Fig. 4 is designed for strengthening the wrists. With the fore part of the arm laid flat upon the table of the machine, the patient grasps the two handles, and slowly raises them, repeating the operation as long as necessary. These handles are not connected with each other, but are hinged on the inner side to the table, and on the outer are connected to a shaft, on the end of which is a short crank, a pin at the end of which fits into one or other of the notches shown around the periphery of the disk, to which are coupled two rods carrying a transverse weighted bar. The effort required to turn this bar upon its center varies with the position of the balance weights.—*Engineering*.

THE UNITED STATES BUILDING AT THE PARIS EXHIBITION.

The American edifice has no studied historical or national character, but is not wanting in dignity and elegance. Its basement tier of building is prolonged at each end beyond the upper tier, the difference of longitudinal dimensions being in the proportion of five to three; above the center rises an open canopy, surmounted by the Federal Republican banner.

HOW TO TEST AND WORK SILVER ORES.

In connection with the development of mines in districts not in the immediate vicinity of machine factories, it has frequently been remarked that commercial success or failure depends in a great measure upon the ability of those intrusted with the management, and that it is really surprising to observe how much the practical man will do with inexpensive apparatus and machinery producible on the spot, while the theoretical manager will place the concern on the road to ruin by waiting for machinery obtainable only after long delays, during which the fixed charges necessarily going on are eating up the working capital, and at a great distance from the mines. But, inasmuch as even among practical men it is found that some are much more ready than others in determining how to adapt themselves to the circumstances of the moment, and utilizing the resources within their reach, such treatises as that of Mr. Charles H. Aaron* are particularly valuable. With regard to Mr. Aaron's competency for the task he has undertaken there can be no doubt, as his name was previously well known as the author of several sound, practical memoirs.

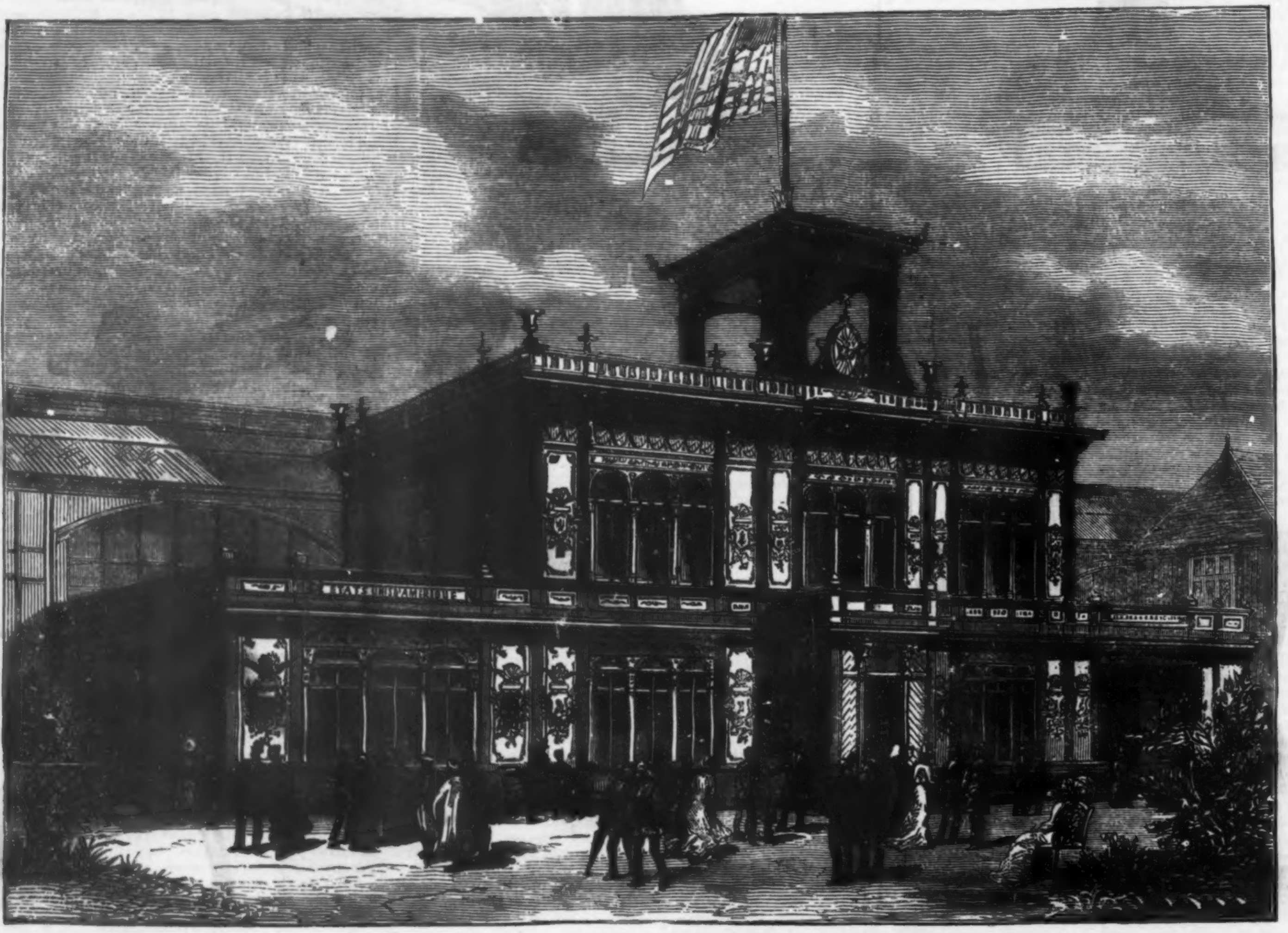
In 1869 he described a mode of treating certain refractory silver ores without roasting, so as to make them yield 90 per cent. of the assay, and this has since been tested on the large scale with excellent results. He now treats of silver mining generally, and writes so as to be understood by common miners and prospectors. He remarks that in all silver regions there is found more or less silver ore in the form of small veins or threads, as the Mexicans say, or in bunches, pockets, and deposits of little extent, which, while they will not justify the attention of capitalists, might yet furnish profitable occupation to a number of miners if the owners only had sufficient knowledge to extract silver in a cheap and simple way.

In the mineral districts of Mexico nearly ever miner has some knowledge, however rude, of metallurgical operations, which enables him to work in one way or another any small rich hilo which he may discover, and though in large operations the Mexican may not be able to compete with more enterprising people, yet it is a fact that among miners and prospectors a Mexican will make a good living where an American would starve to death. Though he writes mainly for the benefit of the poor and unlearned class in the American mining districts, it is not to be supposed that his methods are not adapted to large operations; on the contrary, he maintains that if his modifications of the old fondon of Alonzo Barba had been adopted for the Comstock Mines long ago many millions of dollars which are now in the Carson River might be in the pockets of stockholders, and the value of stocks would be proportionally higher. The whole of his directions are concise and clear. The prospector, having found a sample that looks promising, is directed to grind a few ounces of the ore to powder between two rocks, add to it about one-tenth as much salt, and about half that quantity of sulphate of iron, which is often called copperas, then mix them all together, and after that is done put it into an old shovel or frying-pan, which should have been previously smeared with clay or mud and dried, then roast it over a fire, being careful to stir it often with a piece of stout iron wire. Let the roasting proceed quite gently as long as the smell of burning sulphur can be perceived, not allowing the heat to exceed a dark red, as seen at night. When the fumes of sulphur cease let the heat increase to a rather light red, but not so as to melt the ore, stirring it still with the wire. The smell will now be that of chlorides, rather pungent, often sweet, as of new hay, but very easily distinguished from that of sulphur. The ore will swell and appear woolly and somewhat sticky, and a few minutes of this hotter roasting will finish it well enough for your purpose. Now transfer the roasted ore to a flat rock and let it cool; add a little more salt and enough water to make it like mortar; imbed in the mass a strip of clean sheet copper and let it remain ten minutes; take the copper out, and, without touching the part that has been in the pulp, wash the mud off with clean water. If the ore contains silver it will invariably show as a white coating on the copper, and as no other metal will so coat the copper under these conditions, the appearance of such a coating is proof positive of the presence of silver. The white coating will be heavier or lighter according to the richness of the ore; if very heavy it will appear gray and rough.

Mr. Aaron naturally seeks to reduce his testing apparatus to the simplest form, and hence he only proposes to employ for the tests just mentioned salt, sulphate of iron, an old shovel or frying-pan, a piece of stout iron wire, and a strip of sheet copper 6 ins. long; while for another test he only requires salt, bluestone, a strip of copper, and a teacup or a basin, which can be set in the top of an empty oyster-can. He has never found these tests fail to determine whether the ore is valuable or otherwise. The next step is, of course, to determine what process will be most advantageous to treat it by, for, as Mr. Aaron remarks, although very rich ore will bear transportation to a market, yet the losses, expenses, and discounts which are inseparable from this way of disposing of it have caused miners in general to entertain a strong and not unfounded objection to selling their ores, especially when the market is very distant; and he explains that, whether the mill is to be large or small, it is equally necessary to find out before building it whether the ore can be worked raw, or must be roasted or smelted. Mr. Aaron next describes his process for working ores, and he remarks that his first operation was conducted on about a grain of ore in a minute porcelain cup, with the aid of a copper belt rivet; the next was on 5 lbs. of ore in a kettle, then on 1 ton in a wooden barrel, and subsequently thousands of tons have been worked by it, and near $1,000,000 extracted. The method of working roasted ores, the leaching processes, and smelting are then referred to, and he observes that when a Mexican finds rich ore, and can get galena in the vicinity, he puts up a little furnace of adobes, smelts out his silver lead, refines it in another furnace, and buys beans with the proceeds. Why, asks Mr. Aaron, cannot intelligent Americans, who have opportunities of seeing smelting carried on, go and do likewise? In course of time the knowledge would spread, and many honest miners might profit by their discoveries, instead of waiting for capital, or abandoning their mines because they cannot sell them. Kroencke's process, used at Copiapo, Chili, is next described, and he points out the advantages of light stamps over heavy ones, and speaks highly of Crocker's trip-hammer battery, which is claimed to crush 5 cwts. per hour with 1-horse power. Paul's pulverizing barrel, Kendall's battery, Noice's pulverizer, are fully described; and, referring to amalgamators, he says that the man who, though poor in pocket, has rich ore, need not despair of getting along if he has energy and some ingenuity. A 5-gallon beer barrel will make an admirable amalgamator for 50 lbs. of ore, which, if worth $500 per ton, will yield as much money as 1 ton of Comstock ore at $12.50, the barrel being mounted and turned "by hand or foot, dog, squaw, Chinaman, horse, water, or steam power," while a wash-tub will serve for a separator. Aaron's amalgamator, improved separators, retorts, etc., are in turn described, and there are also explanations of the methods of making various rough-and-ready apparatus of ample efficiency for the practical miner's purpose.

The book, taken as a whole, contains so large an amount of information and occupies so small a space that it should find a place in the traveling bag of every prospector and mine manager proceeding to districts where city libraries are inaccessible. Not only will it enable the practical miner to rely much more fully upon himself when visiting distant countries, but it will prevent him from passing valuable ore deposits which might otherwise escape his notice, as well as from encumbering himself with specimens which contain nothing of commercial utility. The volume will doubtless be widely circulated.—*Mining Journal.*

* "A Practical Treatise on Testing and Working Silver Ores." By Charles H. Aaron. San Francisco: Dewey & Co.



THE PARIS EXHIBITION: THE UNITED STATES BUILDING.

ALIZARINE.

By J. R. Johnson.

[A Communication to the Photographic Society of Great Britain.]

The English traveler who visits for the first time the South of France, and particularly the fertile district round Avignon, will be surprised at seeing large tracts of land covered with the foliage of a plant entirely unknown to him. On inquiry, he will find that this novel agricultural product, so largely cultivated, is the celebrated "garance," the *Rubia tinctoria* of botanists, and the madder of the English calico printers—one of the most important of their dyestuffs.

In France it is very largely used to dye wool of the red tint so well known in consequence of the trowsers of the French army being made entirely of cloth dyed of that color; so that with our neighbors "*porter la garance*" (to wear madder) is synonymous with being a soldier or becoming a soldier. It is also used for dyeing the red, purple, and blacks of our bandanna silk handkerchiefs; the fast purples and pinks of our cotton prints; the perfectly permanent red, pink, lilac, chocolate, and black tints of our often gorgeous furniture prints; and, lastly, it furnishes coloring matter of the brilliant and universally-appreciated Turkey red.

The coloring principle of the plant resides chiefly in its roots; these are taken up from the ground at the proper season, dried, and sent to market either in their natural state or ground to powder, and packed carefully in air-tight casks.

France and Holland send us large quantities of ground madder. From Greece and Turkey it comes to us in its more natural state, under the title of "alizari," by which it is known all over the Levant; hence, when the coloring matter of this dyestuff was first isolated, it received the name of "alizarine."

It would waste your time and try your patience to describe in detail the various processes by which these brilliant tints

are produced from this apparently colorless or but little colored root, although to a chemist they are highly interesting and instructive. It will suffice our purpose to say that they consist—

1. In operations by which the coloring matter is converted from a dormant or merely potential state to one of activity, just as starch and dextrine are converted into sugar by diastase, and by an analogous action and transformation.

2. In fixing of the color on the fabric by first impregnating it totally when it is to be dyed, but only superficially or topically when it is to be printed, with a base or mordant, and when this is fixed within or upon the textile fiber by saturating it with alizarine, in an infusion of madder roots gradually heated to boiling point in a bath formed of an infusion of madder roots. For red and its various shades, such as pink and rose, the mordant employed is a salt of alumina, and usually the acetate; when violet, purple, or black is wanted, the acetate of iron is used—very feeble solutions giving the former tints and strong solutions the latter. For chocolate, brown, and maroon, a mixture of the two acetates is employed, the proportions varying with the shade and depth of color.

3. In the clearing, purification, or development of the true color from the brown matters with which it is associated, by treating the dyed cloth repeatedly with boiling soap lye and solutions of hypochlorite of lime or soda alternately, the brown matters are attacked by these reactives, and are removed or destroyed; while the alizarine compounds to be fixed on the cloth are only purified and enhanced in brilliancy of hue.

When we say that, before Berthollet discovered the value of chlorine in dyeing, madder prints were exposed for several days upon the grass between each treatment with boiling soap, it will be seen how highly resistant the alizarine pigments are to light, which bleaches so many coloring matters.

Alizarine is not only one of our most important dyestuffs, but it is also the coloring principle of many of the most delicate, the most brilliant, and, at the same time, the most permanent tints of the artist's palette, whether he employ oil or water as his vehicle or medium.

You see before you some fine specimens of madder lakes, manufactured and kindly lent by Mr. J. Newman, of Soho square:

1. You have here brown madder, which will give you some idea of the natural color of madder lake before the clearing processes have been applied thereto, although in this case the base is neither alumina nor iron.

2. Here you have Rubens madder, a fine red, alumina being the base.

3. Here you have purple madder.

4. Here are the splendid tints of rose madder, pink madder, etc., of which the base is also alumina.

The pigments you see here only differ from those on the fabric by the fact that the mordants or bases are in one case attached to or sealed, as it were, within the cells of the textile fibers; while in the case of the pigments these bases are free, and combine directly with the coloring principle, as in any other chemical species. The combination is usually effected by dissolving the coloring principle in a solution of alkali, and adding thereto a soluble salt of the base. The base and coloring matter are precipitated together, and the compound so formed is called a "lake." This name originated from the fact of the soluble coloring matter of a particular species of coccus which the natives call "lac" (*Coccus lacca*), which was sent to us from India in a dry, portable form, being so precipitated, under the name of "lac-dye."

Nothing is more easy than to prepare these lakes, yet few things more difficult than to obtain them of the brilliance and purity of the specimens before you—a valuable trade secret.

Even to make an inferior article the madder must undergo—

1. A series of washings to get rid of the soluble impurities when the insoluble coloring matter has been developed.

2. The extraction of the coloring principle, and its precipitation combined with a base.

The preparation of the lighter shades of madder lake is greatly facilitated by the fact that a solution of alum—and particularly alum made neutral by the addition of an alkali until the alumina begins to precipitate—dissolves readily a quantity of alizarine, forming a solution of a fine cherry red, from which acids precipitate the alizarine in nearly a pure state, while alkalies and their carbonates precipitate it as a pink or rose lake.

The necessity of the long and costly operations for the purification of madder colors, whether as dyes or pigments, induced many chemists to endeavor to effect the isolation of the coloring principle in a pure form, so that by using the pure extract instead of the complex natural product the tedious operation of purification might be dispensed with. Robiquet, a French chemist, first published the results of his researches. He believed that madder contained not one essential coloring principle, but two, to which he gave the name of "alizarine" and "purpurine" respectively—evidently modifications of one substance. Although Robiquet failed to establish the extraction of the pure coloring matter as a practical manufacture, he nevertheless obtained it in an intermediate or partially purified state, which, under the name of "*charbon sulfurique*" or "garancine," subsequently became a most important article of manufacture and commerce.

This manufacture was founded on the fact that the coloring principle of madder dissolves readily, and without change, in sulphuric acid, and is precipitated therefrom by water. It was only necessary, therefore, to treat the powdered madder with this acid, and throw the mass into water, to obtain the coloring matter, mixed with carbon, the acid having destroyed or rendered soluble all the other components of the plant.

A long list of chemists might be given, each of whom contributed somewhat to our further knowledge of this interesting subject; but all these researches were thrown into the shade, and the importance of the plant itself greatly diminished, by the discovery of a German chemist that alizarine could be manufactured artificially out of a product of coal-tar. The changes rung upon the elements of pitch, by which that substance is converted into the splendid coloring matter we have been discussing, are of the highest interest to the chemist, but we have not time to consider them. Suffice it to say that the process is thoroughly practical, is performed successfully on thousands of tons of the raw material, and is already, although in mere infancy, a most important manufacture.

By means of scientific research, so often sneered at by practical men, we thus arrive at a process by which a bit of coal can be converted into the substance which yesterday we only obtained by careful preparation of the soil, by skillful husbandry, by careful manipulation in drying, grinding, packing, and by sundry elaborate operations, the result of the labors of many minds. May we not consider the artificial preparation of alizarine as one of the greatest triumphs of modern chemistry?

The practical photographer will naturally ask—How does all this affect us? What have we to do with alizarine and artists' pigments? We reply that since the introduction of photographic pigment printing every photographer who has adopted the new system has a direct interest in every new permanent pigment which the chemist may discover. Henceforth the operations of the artist and the photographic printer are intimately associated. One may exercise genius in the production of works of high art, while the other performs a merely mechanical operation; but the object is the same, and the means employed are nearly identical. Each endeavors to produce "a thing of beauty," and whether that shall become "a joy forever" entirely depends upon whether the pigment employed be permanent or fugitive. The same pigments are employed by each, with certain exceptions; and each employs a vehicle or medium to mould his pigment, and fix it upon the paper or canvas he employs. The painter in oil uses a siccative varnish, which oxidizes, dries, and becomes insoluble in the ordinary menstrua of oil. The photographer uses gelatine and a chrome salt—a mixture which becomes insoluble under the action of light.

Now, it is as important to the photographer as to the artist that the vehicle or medium employed be colorless, or as nearly so as to have no appreciable influence upon the hue of the pigment employed. This condition is fulfilled in both cases. The varnish or megilp of the artist is usually of a slight yellow color in mass, but having no sensible influence upon the color. The same may be said of the medium of the pigment printer. After washing his prints in warm water and passing them through a bath of alum, the medium, which consists of insoluble gelatine and oxide of chrome, is of a very pale-green color, which might degrade somewhat a delicate shade of rose madder, but has no more action upon the brownish purples of the photograph than so much tawed leather—a compound of gelatinous matter and alumina, which it closely resembles in nature and properties.

I particularly insist upon this point, because it has been alleged by an eminent authority that the medium in question is yellow, and that it has a destructive action upon all colors employed with it of organic origin. I will merely observe, to show the utter incorrectness of the statement in question, although this has been already fully pointed out by competent authority, that if the medium were yellow it would be impossible to obtain pigment prints of a brilliant blue color—for blue and yellow form a green or greenish color—and if it had the deteriorating action upon alizarine and other organic matter as asserted, it would be equally impossible to obtain permanent proofs of a brilliant crimson; yet a frame containing impressions in both these colors, from a negative of Mr. Bedford's, the *Old Mill*, printed by Mr. Swan in 1870, hung for years in the windows of the galleries of the Autotype Company, both in the Haymarket and in Rathbone place, and must have been seen by all present, and prove conclusively not only that such prints are obtainable, but also that when obtained they are perfectly permanent.

Having shown the importance of permanent pigments to the photographer, I will now proceed to show how such a pigment may be procured from alizarine; for, unfortunately, none of the madder lakes I have shown you can be employed successfully for that purpose. The crimson, rose, and pink lakes, which have alumina for their base, when mixed with a small quantity of very black pigment on the palette of the painter and diluted with this medium, yield most brilliant tints, quite equal to those yielded by cochineal, and those which the photographer obtains from albumen and chloride of silver exposed to light and toned with a salt of gold; but when these pigments are mixed with the photographer's medium insolubility ensues without exposure to light, and the pigment paper no longer performs its functions.

Such, at least, has been my experience and that of others. I have always hitherto explained this action by supposing that when the alumina was in sufficient proportion to the alizarine to constitute a permanent pigment, such pigment, when mixed with gelatine and an acid chrome salt, yielded a portion of its base to the acid of the salt, and precipitated the gelatine, as acid salts are well known to do.

The process by which Mr. Swan obtained permanent prints in alizarine having been found to yield uncertain results, unless the greatest care was taken, I succeeded in preparing an alizarine compound in 1872 which was free from this defect, which had no action upon the gelatine medium, which gave beautiful and permanent colors, and which, although capable of yielding double transfer prints of the most brilliant tints, yet this compound appears to have been ignored or abandoned by the company, for on the technical manager of the company visiting me in Paris, in 1876, he was unacquainted with it as a manufactured article. Hence it is not surprising that, on the publication of the fifth edition of their *Manual*, the practice of the art had so far been altered that, in answer to many queries as to the want of permanency of pigment prints, its chief promoters had to admit that to obtain what was termed an "exaggerated" brilliancy fugitive colors must be had recourse to. I would ask whether any brilliancy beyond that yielded by silver and gold upon albumen has been asked for or attained.

I am aware that this admission is now withdrawn and a better practice instituted, but not without some exceptions, for special licensees are still supplied with fugitive pigment papers at their own request. At any rate, so long as the new practice is maintained a trade secret, I hope that it will not be deemed superfluous for me to describe the mode of obtaining permanent pigments with alizarine, and to explain the conditions necessary for that object.

First, let me say that alizarine, like a great many dyestuffs, is not permanent alone, but must be combined with a due proportion of base. It is not sufficient merely to precipitate the alizarine from its alkaline solution by so much alum as is necessary for the purpose, for alizarine is precipitated by acids, and alum is an acid salt. The lake so produced may be very intense and brilliant, and may be perfectly insoluble in water; but if it be insufficiently charged with base, it is not the true permanent lake, but that substance mixed with a quantity of the uncombined color which will yield to the action of the light. Hence it is not surprising, therefore, to find that certain photographic prints made with alizarine have been found to be fugitive, or so fugitive as to destroy the beauty of the tint and the intensity of the shade of color.

When, therefore, Dr. Monckhoven, in the paper to which I have referred, laid before you prints made by him with pigments which contained alizarine, no surprise should have been excited, because in the same paper he furnished you with an explanation of the cause of this fugacity. He informed you that it had been denied that iron and alizarine would produce a red color, but that this was so provided that the iron was in small quantity. He stated, moreover, that he used, or had used, such a compound.

Now, I have here a piece of cotton print the design of which is produced by iron and alizarine, the acetate of iron having been first printed on the fabric in two degrees of concentration, and the oxide after due preparation saturated with alizarine in the dye-bath. You will perceive, even by this yellow light, that we have two tints—one of violet and the other of black; that is, of violet so intense as to appear black. Judge, then, from these tints—which are those of the natural compound of iron and alizarine, one diluted and the other concentrated—how small a proportion of the iron base Dr. Monckhoven's compound must have contained not to have converted the crimson tint of the pure alizarine into the violet of the pure pigment, and hence its incapacity to resist the action of light.

En passant, I may observe the cotton print before you furnishes us with another proof that in making the statements he did Dr. Monckhoven was in error. Knowing that the notorious permanence of the alizarine compounds on cotton and other fabrics could not be denied, he attributed that permanence to the degree of depth or penetration of the color into the fabric, thus ignoring one of the axioms of the calico printer, viz., that the topical color must be of infinite tenuity upon the surface of the fabric to obtain the maximum degree of brilliancy. He effects this in two ways: First, by the extreme shallowness of the intaglio design upon his engraved copper roller; and, secondly, by thickening his solution of iron or alumina salt with starch, dextrine, or gum, so as to prevent the mordant penetrating the cloth.

You will see in the print before you to what extent this principle has been carried, the light parts of the design lying in an extremely thin plane on the surface, exactly like a pigment print.

We have shown the cause of instability in Dr. Monckhoven's hands. It is possible that the same cause may have operated in the prints made by him from the pigment paper of the Autotype Company, which were also found to be modified by light, and which must have been made with alizarine if, as they allege, all their pigment paper issued since 1876 has contained that coloring matter.

If, to render the alizarine compounds permanent, a certain quantity of alumina is necessary, and if, when in that quantity, it renders the medium insoluble, how are we to apply this valuable coloring principle so as to render it a proper pigment for the use of the photographer?

I have solved the difficulty completely by using so much alumina only as suffices to develop and maintain the red color, and then adding another base—a salt of lime or magnesia—in sufficient quantity to render the alizarine not only completely insoluble, but also permanent.

Here are numerous specimens of the prints produced from such pigment paper, both in double and single transfer. I will only add that such prints have been tested for stability by Mr. Simpson and others, and stood that test without flinching.

Having given some years of my life to render this beautiful art practical, and its products permanent, I trust I may be pardoned when I say that I read with pain and regret the defense made on a late occasion when the permanence of pigment prints was called in question. It appears to me that, so far from that being a successful defense, it was a mere plea of "guilty" with extenuating circumstances.

It is not thus that carbon or pigment printing should be defended. It needed no such defense when it left Mr. Swan's hands; it was then free from this stigma.

Henceforth I undertake to demonstrate practically that by means of alizarine every tint needed by the photographer can be produced by the pigment printer with a brilliancy equal to any that can be obtained by cochineal, and with the known permanence of madder lake. Let any desired tint be sent to Mr. Sarony, and we pledge ourselves that such tint shall be reproduced in permanent color.

There is one more point on the practice of pigment printing to which I would allude. After obtaining permanent prints with alizarine, it was found that they were affected by immersion in the alum solution, which, as I have already stated, is a solvent of alizarine; hence, when the finished prints were allowed to remain some time in the alum bath, both a sensible amount of the red color was dissolved out and an appreciable effect upon the tint produced.

It is a curious fact that while the true alums, the double sulphates of alumina, and potash or ammonia possess this solvent action upon alizarine, the simple sulphate of alumina is quite inert, yet apparently equally efficacious in fixing the gelatine print, so that the latter may with great advantage be substituted for the former wherever alizarine prints are produced. The only drawback I know of to the use of alizarine pigment prints is thus effectually removed, as Mr. Sarony has proved by several months' experience.

THE DUSTING-ON PROCESS.

By Dr. JULIUS SCHNAUSS.*

THE process for producing encaustic photographs on porcelain, glass and enamel, for which a patent was taken out in the year 1860, by F. Joubert, in London, forms the foundation for the direct reproduction of negatives, which is of so much value, more especially in the carbon and collotype processes. Before that time it was impossible to reproduce a negative unless by the roundabout method of a diapositive, either by a direct copy—by means of a dry plate for development, of silver chloride collodion, or of a pigment print—or else by a second exposure in the camera, and from this, in the same way again, a negative. It is easy to see that there is here great room for intentional, and still more for unintentional, departures from the original, as regards both vigor and intensity. The shorter, therefore, the process of reproduction is, the better; and in this, as well as in many other respects, the dusting-on process deserves the prize. Only in the case where the original negatives have been specially taken for collotype or carbon prints could the reversing of them by means of transfer to gelatine be preferred. The process published by Ad. Braun always gives the best results.

The original method of Joubert is essentially the same as that now employed by Obernetter and Husnik for the reproduction of negatives, except that, as is self-evident, Joubert used a transparent positive, and dusted his copy with vitrefiable pigments, whereas the others employ a negative with graphite according to Obernetter, or finely powdered black chalk according to Dr. Liesegang, for the dusting-on.

Joubert's process was as follows: He made two solutions; the first of one part of ammonium dichromate in four parts

* Photographisches Wochenblatt.

water, boiled and filtered; the other of three parts of good honey heated to 38° C., and the same quantity of well beaten and fined white of egg. The two are then thoroughly mixed; and the whole is filtered, and kept protected from the light. This solution is flowed over a well cleaned glass plate, the same as collodion; to assist its spreading evenly, breathe on it, and use a clean glass rod. So soon as the excess is drained off, the plate must be dried at a moderate heat, but with a very faint light, and, while still lukewarm, exposed behind a transparent positive (in our case behind a negative) for one minute to direct sunlight, or from six to ten minutes in the shade. And now the peculiarity of the process manifests itself: a non-exposed plate becomes perfectly black under the dusting powder, just as an under-exposed collodion plate under the developer, while the longer the exposure the greater is the faculty it displays of repelling the powder, until, with too long an exposure, it will not blacken at all. And in this property, which is in complete contrast to that of other sensitive films, lies the explanation why in this process we obtain a copy with the same characteristics as the plate from which it is taken—that is to say, a positive will produce a positive, and a negative a negative. It depends on the fact that the film, in its original condition, is easily moistened, or hygroscopic, so that it attracts and retains the powder; but that, after exposure, under the influence of the chromic salt, it becomes horny and insoluble in or even repellent of water; in the places, therefore, that have been acted on by light no powder will adhere.

Eighteen years have elapsed since the first publication of Joubert's process, and during this period several modifications and improvements have been introduced; but the method of fixing the developed image remains the same: it is coated with thin, raw collodion, and, after drying, is laid in water to wash out the chromic salt, an object which the porous nature of the collodion film permits of being attained with ease. Unfortunately, notwithstanding the collodion, the entire picture in drying often rolls up and detaches itself from the plate. On this account I prefer to adopt the plan of coating the collodion film while still moist with a dilute solution of gum; it will also answer the purpose to paint the edges of the collodion before it is washed with a thin solution of caoutchouc or a little negative varnish—unless an image has been so coated with collodion. I have never yet succeeded in washing in spirits of wine or acid without injuring it. Quite as difficult is the coating of large plates, and evenly drying the layer. In this case it is better to proceed as in the collotype process, and to dry the plates in the dark, and in an accurately horizontal position.

By employing the following method, of my own invention, I have produced very good and even films. After thoroughly cleaning—or, still better, albumenizing—a glass plate, I coat it with raw collodion, and, when the latter is nearly set, I dip it into the sensitive chromate bath, just as an ordinary negative is dipped into the silver bath. To produce equal moistening the plates must be carefully watched, when even on those of the largest size is obtained a smooth and thin film of the hygroscopic-chromate solution. The plate is then allowed to drain, and dried over a lamp with the precaution that the edge from which the liquid flowed off should be kept a little lower. If a thicker layer be desired it can be obtained with great ease by pouring the chromate solution a second time over the plate. As is always the case in this process, the plate must be laid under the negative while still lukewarm.

For dusting the Siberian graphite is the best, but most expensive. The German graphite, after being dressed and dried, then moistened with spirit and washed, gives fairly good results. Cingalese graphite does not answer the purpose; but English succeeds better. Pains must be taken to have the dusting-brush, the paper support, the powdered graphite and the plate all perfectly dry (in damp weather they should be slightly warmed), or the image will be smeared. For the same reason breathing on the plate to intensify the blackening must only be done with the greatest care; it is, perhaps, better to leave the plate after it has been dusted for a few minutes in the dark, when it will have drawn sufficient moisture from the air. The broad dusting-brush must be passed lightly up and down the plate, and made to push a little of the powder always in front of it. The negative must not be allowed to get too intense.

The chromate solution soon decomposes; it is therefore advisable to keep the solution of the chromic salt separate, and only to measure it off and mix it as it is required. The graphite powder penetrates the entire film as far as the glass, so that a faint image remains on the latter after the former has been removed, and this image will appear positive or negative, according as it is held against a light or dark ground.

Dr. Liesegang's formula for the preparation of the sensitive solution is as follows:

Rain water	1 liter.
Gum arabic	50 grammes.
Glucose or dextrine	50 "
Honey	50 "
White sugar	20 "
Glycerine	5 "
Cold saturated solution of ammonium dichromate	100 "

In Obernetter's formula the gum and honey are omitted, and the amount of glycerine varies with the hygrometric condition of the atmosphere.

Professor Husnik has lately prepared for sale two solutions of this kind, slightly differing from one another. To his kindness I am indebted for the receipt of two flasks of his solution, with which, for the most part, I have made my experiments; but I am not able to say whether it differs in composition from those prepared by the above named formulæ. It is claimed for Husnik's solutions that they will keep good for a long time, which certainly is not true of the ordinary one; the odor they give off when the plate is drying betrays the presence of oxgall.

The collodionized film can be removed from the plate under water, especially when a little acid is added; it can be inverted and transferred to other supports, a condition which in the case of the enamel process is of great importance. Also enlarged as well as diminished direct negatives can be obtained with it by means of the camera. It is quite within the power of the operator to produce a vigorous and hard (by long exposure) or a soft and weak image. By this means the defects of the original negative can be corrected. It stands to reason that plate glass plates must always be used; also that albumenizing the same must be omitted when it is intended to invert and transfer the collodionized film.

A NEW enemy to the vine has been recognized in the Anthragnosis, a species of fungus.

M. MICHAUD'S PHOTO-ENGRAVING PROCESS.

LIEBERT's work is so completely up to date that we find in it an account of the latest invented process of photo-engraving by M. Michaud.

It was only at the last meeting of the *Société Français de la Photographie* that M. Michaud, a pharmaceutical chemist of Grenoble, and an amateur photographer, exhibited the first specimens of his process, which he has recently patented, and which seems to be capable of important applications. The method consists in first taking from the negative to be reproduced a print on bichromated gelatine, as in the ordinary processes, and having as a support a metal plate. After developing, it is dried in the open air, and is then placed in a box which has a bottom formed of some hygroscopic substance; the moisture from this substance causes the gelatine to swell slightly, so that the relief is still more accentuated. By means of a brush the layer is removed from the plate, and applied to a form of fusible metal which is just heated enough to render it liquid. Passing the form under a press, the fusible metal, in solidifying, preserves an exact impression of the image on the bichromatized gelatine, and thus is obtained a solid plate which may serve many purposes. The fusible metal which M. Michaud employs is composed of—

Darcet's alloy	1,000 parts.
Mercury	110 "

But the proportion may vary according to the greater or less degree of hardness which the plate is required to possess. This latter can now be used for obtaining transfer prints for lithography or typography; it also can furnish either raised or sunk moulds for electrotyping. When the original negative has been taken from nature, or from a drawing possessing half-tones, it is essential to produce on it a grained surface, as without it the half-tones would not be copied. For this purpose a special pellicle of bichromatized and colored gelatine must be prepared; it is exposed under a glass which has been uniformly dusted with some opaque powder. This pellicle is applied under water to the negative after the latter has been coated with a film obtained by pouring over it a solution of ten per cent. of gum arabic in water to which a quantity of potassium bichromate (to the amount of three grains to the liter) has been added. Development is effected in lukewarm water, when all the gelatine not affected by light is removed, while the parts that have been exposed remain intact. In this way a grain is formed on the negative, and is reproduced in the plate from which an impression has to be taken. The relief from which the electro-plated moulds are produced has been ingeniously modified by M. Michaud, but we have no space here to go into any further detail. To sum up: we obtain by M. Michaud's process metal plates in inverse, from which impressions may be taken on paper or on stuff; or transfers for lithography and typography; or, in short, almost any kind of plates which can be economically employed on the different kinds of ordinary engraving.—*Photographic News.*

A NEW SUBSTRATUM.

By HENRY COOPER.

SOAK sixty grains of Nelson's photographic gelatine in water, drain, and pour on enough boiling water to make eight fluid ounces. Now add two drachms of a ten-grain solution of chrome alum, and stir vigorously for a minute or two. Filter the solution through paper into a clean measure, keeping it warm, and avoiding air-bubbles.

To save trouble, a large quantity of each of the solutions, the gelatine and the chrome alum, may be prepared, and will keep for a long time if a little pure carbolic acid be added to each. No more must be *mixed* than is required for the batch of plates, as when the compound solution has once become cold it cannot be again liquefied with heat. The measure and filter used must be well washed with warm water as soon as done with, for the same reason. The cleaned plates are immersed in a dish of warm water. They are taken out one by one, attached to a pneumatic holder, swilled with warm water, and the surface flowed twice with the gelatine solution (which must *not* be returned to the pourer, but may be to the filter), and, if care be used, very little will run over the back of the plate. After coating, the plates are placed in a light deal box, the bottom of which is covered with three or four thicknesses of clean filtering paper, in such a way that only one corner of the glass touches the side of the box. The lower edge rests entirely on the filtering paper. Cover the box to exclude dust while the plates are drying. They are ready for use very soon, though they improve much by keeping for a day or two. Hence it is advisable to prepare a good number at one time.

Although all this sounds troublesome, it does not take so long to prepare the plates in the manner just described as it does to dry and polish them in the ordinary way.

MANUFACTURE, PROPERTIES, AND USES OF DYESTUFFS.*

IF we examine logwood, which has probably a much greater consumption than all the other dyewoods put together, its colorific properties are developed by the most feeble agents, and very feeble agents also destroy its color, unless it be fixed with a mordant. In this respect it differs from indigo, in which the color is similarly developed by feeble agents, such as exposure and water, but the color, when developed, is very permanent. The colorific properties of both logwood and indigo are white during their growth, and the color of both is developed by water and the atmosphere under conditions favorable for oxidation of same. The trunk and thick branches of the logwood tree are imported to this country in the log, and in due course such wood is ground and submitted to proper oxidizing influences, termed "conditioning;" while the color of the indigo plant is found richest in the branches and stems of the plant, assuming a permanent form when extracted from the plant by the natives. Indigoes, as imported to this country, are insoluble in water; and to produce permanent dyes upon textiles with them, they are reduced by fermentation in the woad vat to the state of white indigo, in which condition it becomes soluble and readily taken up by the goods introduced into the vat. On being removed the goods are exposed and washed, and as the indigo gets supplied with oxygen from the air and water it takes again the blue color, so that the strong light and moist atmosphere which affect unfavorably most colors are in this case the supporters of the color of indigo-dyed stuffs.

Now, logwood is fresh ground, or rasped, in order to develop its color; it is moistened with soft water, slightly warm, then laid up in heaps, and here again we have that *contentious* word "fermentation," for the authorities state that the moistened dyewood must be allowed to remain in heaps for a few weeks, until by fermentation the color is fully developed, and that care must be taken to turn the wood over occasionally to prevent its becoming overheated.

Now, in this case I take it that oxidation generates heat, and that a little warmth and moisture favor oxidation, and that development of the color is a natural consequence; that heat is first generated in the heaps of dyewoods thus laid up to condition by oxidation, which if not stopped by turning and exposing, *fermentation* sets in, and decomposition of the colorific properties of the dyewood is the result, which entirely destroys the color-giving properties of the wood; that in my opinion fermentation of logwood results in decomposition and destruction of its colorific properties, while the full development of the rich purple color contained in it is the sole result of oxidation. And here again water plays a most important part, and is made the agent to convey oxygen, and bring it in immediate contact with the dyewood. When the color is fully developed it assumes a slightly bronzed appearance, readily yielding its color to boiling water. Logwood has little or no affinity for the textile fabrics; alone it would have but little value as a dye, but when united with mordants it occupies the first place as a dyewood; therefore with it, it is the mordants we consult for producing the various colors. To produce blue black, or full black, with logwood, we mordant with various proportions of bichrome; for purple on woolen stuffs with logwood, we mordant with alum; and for cotton stuffs, we mordant with tannin and tin spirit; and for lilac, with tin spirit only; and for black upon cotton, with tannin and iron, or sulphate of copper, etc., etc. These hanks have been mordanted as just described, and one has received no mordant; they have been dyed in logwood liquor of uniform strength, while the one not mordanted has taken up little or no color at all. You observe each hank has dyed its respective color, namely, full black, blue black, purple, lilac, &c. This is explained when we consider that mordants, which are in themselves colorless, as alum and tin, become fixed upon the tissues; they allow the logwood to unite in its natural purple color. The lilac having had the most feeble mordant, cannot unite with so much color, which has been shown in the dyed results with regard to blacks. The mordant for black is bichrome, a salt of a bright red color, yielding yellow and orange solutions. Such colors are capable of being precipitated or united upon cotton with acetate of lead, but when worsted stuffs are boiled in a dilute solution of bichrome, the latter becomes united firmly with the worsted, imparting to it a buff or yellow tint, and a strong mordant or affinity for dyewoods; so that when boiled in logwood solution the purple color unites with the mordant, and black is the result. The mordant bichrome becomes in the process oxide of chromium, which has a dull green color; and when the green has united with the purple dye of the logwood, the two form black; and up to this present time there is no such thing known as a simple black dye. The various shades of black on worsted stuffs are influenced by the proportionate use of bichrome and logwood. Blue black being the lightest in shade, requires a more feeble mordant than full black, and excess of bichrome would yield green blacks, while the minimum quantity would allow more of the rich blue purple color of the logwood to show itself, which color would remain more permanent than in cases where excess of bichrome had been used; that is in consequence of the greening influence of the oxide of chromium continuing to reveal itself after the goods have passed into the hands of the consumer.

For experimental proof of the above remarks, take three hanks dyed with logwood upon various strengths of mordant with bichrome; and with proper proportions will be obtained three very distinct blacks, one blue, almost like indigo blue, one green black, and one the ordinary black. In further proof that green and purple form black, take the sour dyeing process in which each color is added pure and separate; as, for instance, sulphate of indigo, and any of the yellow dyes, but not in excess—these two colors form green, then add the purple dye, cudbear, and all shades of black can be produced on wool by varying the proportions. Excess of yellow dye in this process, like excess of the mordant bichrome with logwood, yields green blacks, while a deficiency of the yellow dye yields blue blacks with a rich bloom.

In the preparation of indigo for the use of the dyer, we deal with sulphindigotic acid, known in the stuff dyehouses of the district as chemic, liquid-extract, and paste-extract of indigo. These are all indigo in combination with sulphuric acid, "chemic" being ordinary indigo dissolved in that acid, and, in consequence of the impurities present in the native indigo, it is only employed in the dyeing of browns, olives, or other dark colors; while liquid-extract of indigo is refined indigo dissolved in the same solvent, and may be used for dyeing some of the brighter acid colors; while the paste-extract of indigo is made from both the common and refined indigo. These articles are far the most important of the indigo products. The principle involved in the preparation of them is to make all such indigo soluble in water, and to have present that proportion of sulphuric acid which is most acceptable to the dyer for the special uses for which it is required, and very excellent and genuine products can be obtained from many of the manufacturers of these districts. Practically, all indigo sulphates prepared for the stuff dyehouse are intended to be used in the dyeing of worsted or woolen stuff, and are fixed with acid or acid salts, to which there are some exceptional uses and conditions. Colors which are dyed with indigo-sulphates are discharged with alkalies, in which process the color itself appears to be decomposed and destroyed; therefore, the dyes produced by the salts of indigo, although much brighter and purer in color than the native indigo-dyed stuffs, do not possess the permanency of the latter. Indigo, as a salt, is not more permanent than the generality of dyestuffs; and it appears to be the rule that acid salts are less permanent than alkaline salts; this applies equally to the aniline blues also. In confirmation of this, two hanks, both dyed blue with aniline blues, one with the alkaline salt, the other with the acid salt, when in warm water made alkaline with soda, are almost instantly decolorized. After washing, put them in the acid bath, and only one remains partially discharged; the other has its original blue color restored; so that one dye unites itself with the worsted much more firmly than the other. The cause of this is that the discharged color had been dyed with an acid salt of aniline blue, similar in its composition to the paste-extract of indigo, made very soluble in water; and where goods dyed with such colors are treated with alkalies, the color itself dissolves off into the bath, decolorized, and in some cases destroyed. This is not the case with the aniline blue, for by making the discharge-bath acid the color in the bath is restored. This hank is dyed blue with the ordinary paste-extract of indigo, and is instantly decolorized by the alkali. On washing and then putting it in the

* Abstract of Chemical Laboratory Lecture, delivered by Mr. James Sharp, of the Dyeworks, Pickle Bridge, near Bradford.

acid bath, it remains discharged. Now make the discharge-bath acid as before, in this case no color is developed; and if such color had not been decomposed—destroyed by the alkali—it would now be restored. Thus is proved that the salts of aniline blue are more fixed than the salts of indigo blue. Now, with regard to the aniline blue dye, which remains fixed in the fiber in the presence of both acids and alkalies, such blues are known to chemists as the monacids of triphenylic rose aniline. Such blues are first manufactured with the greatest care into a condition which enables them to unite with alkalies only, hence they are termed alkaline blues. In this condition they are united with the textile fabric, and appear almost colorless. When sufficient dye has been combined, the goods are removed from the dye bath and washed; afterward they are passed through an acid bath, which develops the dye previously united with them; when blue-colored goods, which have been dyed with these alkaline blues, are reimmersed in alkaline baths, such alkali deprives the goods of the acid which developed the dye into blue, but the dye itself mostly remains fixed upon the tissues in its original colorless condition, and only requires immersing in the acid bath to show its presence. In the production of these bright dyes, the greatest care and skill is required in all the manipulations, and very low qualities of blues are quite incapable of being manufactured to have similar properties. For instance, the aniline blue known as induline, or indigo substitute, the nature and properties of the materials employed for the manufacture of this dye, and the temperature employed in the process, are such that it can never hold so high a place as the bright alkaline blues; for this reason, it is not so soluble, and does not unite readily and firmly with the materials to be dyed. If worked with alkalies, the color is mostly held in solution in the bath, while acids separate much of the color, and produce dirty dyed stuff. Therefore neutral or slightly alkaline dye baths are recommended, and acetic acid to be added to the dye bath during the process, which can never be entirely satisfactory; hence this color is consumed entirely in the low woolen districts.

In the purification of indigo for commercial purposes, the process is by deoxidation, etc.; the materials employed to effect deoxidation and solubility, by which the impurities of the indigo are removed, being sulphate of iron (green copperas) and caustic alkali, as lime or soda. Green copperas has the formula of $FeO.SO_3 + 6H_2O$, and is composed of one proportional of protoxide of iron, one proportional of sulphuric acid, and six proportionals of water; the influences which this copperas exercises upon the indigo while being purified, and the reactions they give rise to, are not difficult to understand. The indigo is first ground very fine, with sufficient water to give it the consistence of a thin paste; this is generally done in a reeling mill, or cradle, capable of grinding at least 100 lbs. at once. The vats, or other apparatus, are charged with the necessary materials, and under a proper treatment the copperas unites with the oxygen present in the indigo and water, thereby reducing the blue indigo to white, in which condition it is soluble in the lime or other caustic alkali which may be present, so that the coloring properties of the indigo are held in solution; while that which was copperas, together with the impurities of the indigo, are mostly precipitated by the alkali present; and when deoxidation of the indigo and precipitation of the impurities are completed, the clear liquors are withdrawn, and the residue again treated for the indigo remaining by admixture. The clear liquids containing the white indigo have also in solution some little of the impurities of the original indigo, among which are a brown or red color, which is now soluble in water. Therefore, by precipitating or otherwise separating the indigo, such brown or red color, with other impurities soluble in water, are removed; and the indigo is thoroughly washed and desiccated; and such purified indigo possesses all the pure indigo blue contained in the original indigo, although it may have lost 50 to 60 per cent. of its original weight. It is extremely probable that all the indigo imported to this country, and for which such high prices are paid, does not contain near an average of 50 per cent. of pure indigo blue. Indigoes, purified by deoxidation as described, when proper care and skill has been employed, are almost pure indigotine; but the quality is influenced by the climate, soil, etc., in which the native indigo is grown. Dyers use with advantage indigoes prepared to contain various proportions of sulphuric acid, and is guided in the use of such preparations by the conditions which present themselves, namely—if he has to dye very dark greens or olives, he must use a large quantity of indigo sulphate; and if the quantity of free acid present in chemic or liquid-extract be calculated to destroy or otherwise injure other colors which are necessarily present, or endanger the strength of the goods he is about to dye, he resorts to paste-extract of indigo, from which most of the free acid has been removed. The nature and condition of the goods must also be considered, otherwise unfavorable results will be obtained. Alum is largely used to fix the colors which form green, and when the goods reach the dyer in a neutral condition, no difficulties are experienced when the ordinary course is adopted; but in the dyeing of some heavy all-wool goods (say with sized warps and greasy weft), which have been insufficiently scoured and washed, leaving the goods in an alkaline condition, if free acid were not present in the dye bath more than sufficient to neutralize the alkaline condition of the goods, the result would be that the alum would be deprived of its constitutional acid, and this dissociation of the alum would cause hydrated and dehydrated alumina to become deposited upon the goods as a white precipitate, giving a most objectionable handle and appearance to the goods. Therefore, it is most important to keep the dye bath in good working condition, as both quality and quantity of work are influenced materially by such condition, while what is known as dirty loose dyes are influenced by a variety of special conditions which are best dealt with separately as circumstances arise.

THE INFLUENCE OF GLYCERINE ON THE FIXATION OF INDIGO.

By M. PRUDHOMME.

BEFORE entering on the question which forms the subject of this note, I may recall the works of some of my predecessors, quoting in the order of their purity. First, the steam indigo blue with cyanide of potassium of M. E. Schlumberger; second, the applications made by M. Albert Scheurer of the hydrosulphite blue of Schutzenberger and Lalande; lastly, two accounts more intimately connected with my own work, and of which they may be said to contain the germ—one by M. Jeanmaire, in which he treats a fast alkaline blue with tartrate of iron, and there happily shows the influence of glycerine upon the fixing of fast blues—the other more recent one of M. Zurcher sets forth a new process of steam indigo blues, which, though not yet an industrial process, is none the less interesting.

By printing an indigo color with a paste consisting of oxide of tin and an alkaline bicarbonate he obtained reduced indigo upon the tissues, though the results were only good for patterns lightly steamed—that is to say, in a strong continuous current of very moist steam. M. Jeanmaire, who was appointed to report upon this work, confirmed the conclusion come to by M. Zurcher, and while enlarging upon the question, and showing that the alkaline carbonates may replace the bicarbonates, he nevertheless made some reservations upon the peculiar causes which favor or hinder the reaction during steaming.

I come now to my own personal experiences. If we try to reduce indigo suspended in water by alkaline carbonates and oxide of tin in paste, the reduction is imperfect, even though we maintain the liquid at the boiling point for a considerable time; but if we replace the water by glycerine, we obtain, after a few minutes' boiling, a yellow solution of perfectly reduced indigo. The reaction begins in the cold, the liquor assuming a tint more and more green, but is only complete when clearly indicated by the yellow color so characteristic of the reduced indigo solution, and when a thermometer placed in the liquor indicates from 110 to 120 degs. C.

I may now allude to the method which I adopt. If we print a color composed as follows, viz.—

45 grammes powdered indigo,
150 " oxide of tin,
300 " soda crystals,
½ liter of thickened gum and glycerine—

it behaves as the corresponding color of M. Zurcher (in which water replaces the glycerine), that is to say, it only gives good results with slight steaming.

Upon tissues prepared in greasy acids the color is finer and faster. I may remark *en passant* that this blue, like all indigo blues, even fixed on tissues, loses color in steaming, becoming more gray, which has, up to the present, hindered from printing in the illuminated dark blue with madder extracts or artificial alizarine.

It occurred to me that the reason that my color with glycerine did not yield good results with steaming was because of the conditions of temperature (110 deg. to 120 deg. C.), or steam pressure being defective. I therefore made the following experiments, which, however, did not confirm this hypothesis, but, on the other hand, led me to very singular results. The non-reduced color of which I have given the receipt above is printed, and (1st) a pattern is put in boiling water, without any trace of reduction being observed, however long the immersion; (2d) by replacing water with glycerine, warm or boiling, the color is reduced on the tissue, becoming yellow, afterward being re-oxidized in the air; (3d) by raising the boiling point of the water to 115 deg. or 120 deg. C. (by adding nitrate of soda, a salt without reducing action), the result is nil, as in the first case. It is the same with oil heated to 120 deg. C. It became necessary, therefore, to return to this idea, that glycerine possesses peculiar reducing properties; and, with this view, began a series of experiments, which, in order to avoid all sources of error, I made with pharmaceutical glycerine, at 28 deg. Baumé, distilled in superheated steam. Moreover, I made sure that it contained neither lime, sugar, gluten, nor dextrine. Its boiling point was higher than that of commercial glycerine, approaching 140 deg. I need not give in detail these experiments; suffice it to say, that I varied systematically the conditions in such a manner as to obviate all secondary actions; and I have come to the conclusions, which I can state with certainty: Firstly, that glycerine alone, heated in presence of caustic soda, reduces indigo. Secondly, that glycerine and oxide of tin bring about the same results, or, rather, the formation of a white indigo precipitate. If oxide of tin, in paste, be added to the glycerine which I used, and brought to the boiling point, it produces a tumultuous reaction, probably partly due to the expansion of the steam, and the indigo is instantly reduced. With white commercial glycerine, at 22 deg. B., it is necessary to boil a lengthened period. I have left on one side brown glycerine, at 28 deg. B., which is strongly charged with lime.

What then is the action of caustic soda on glycerine at a certain temperature? It has already been studied by MM. Dumas and Stas, and can be formulated thus:

$$C_3H_8O_3 + 2NaHO = C_2H_3O_2Na + CHO_2Na + 2H_2.$$

The reaction of soda and glycerine is not confined to a simple reduction, as by prolonging the contact, or by raising the temperature, it is, I believe, partly destroyed, as is proved by the formation of a greenish gummy matter. With regard to the action of the oxide of tin on indigo in the presence of glycerine, I am disposed to give an analogous explanation, not forgetting the reducing power which it alone may possess.

It will now be understood what is produced when a pattern is passed through heated glycerine, and printed with a color containing these three substances, viz., indigo, soda crystals, and oxide of tin. Stannite of soda is formed, and to its reducing power there is added the result of the two fundamental reactions which I will presently allude to. It also explains why my color with glycerine in steaming does not give results superior to those of M. Zurcher, for the small amount which penetrates the fiber or is maintained on the surface by the thickening is insignificant compared with the mass of the color itself. I may add, that however perfect the reduction of indigo on the tissue may be, after a passage in glycerine the fixing of the coloring matter by reoxidation in the air is unsatisfactory. I attribute this fact (even extending the observation to the generality of steam indigo blues) to the insufficiency of alkali present. The indigo is well reduced, but not being dissolved does not penetrate the fiber.

My researches are not confined to indigo; I have extended them to the aniline colors and to several substances of the anthracene series. The alizarines and the rufigallic acid are reduced warm by means of glycerine, oxide of tin, and an alkaline carbonate, all the three giving a dirty yellow solution, containing reduced products, bearing no resemblance to the primitive bodies. I lay great stress upon the part glycerine plays in exalting the reducing action of certain bodies. Zinc powder on glucose and an alkaline carbonate reduces indigo in a more rapid manner in the presence of glycerine than in the presence of water. To sum up, we have two new indigo reducers; and, however imperfect it may be, a new mode of fixing one of the oldest coloring matters known is added to the process of fast blue, steam and china blue. It may almost be said that it pertains to all three. Indigo printed unreduced is a china blue; the color containing a portion of the reducing agents is a fast blue; lastly, the temperature being brought up to where the reaction takes place it may be almost considered as a steam blue. In conclusion, I may say that in these researches I used for thickening gum senegal dissolved cold in glycerine (1 kilo. gum, 2 liters white glycerine). A color made with this thickener after the manner of those of which I have given the tenor is preserved indefinitely. The same color made with gum water is coagulated the next day. The using of starch with glycerine presents the same advantages as the employment of starch in the ordinary way. This observation may be compared with that of M. Gros Renaud. Alumina is dissolved at 70 deg. C. in glycerine without coagulating. The gum water, with a little alumina added, possesses comparatively the same properties as the gum water above.—*Textile Manufacturer.*

NEW DISCHARGE ON INDIGO BLUE.

By OSCAR SCHUERER.

BY printing minium (sesquioxide of lead) on cloth dyed with indigo and passing afterward through weak hydrochloric acid, a good white is produced even with very weak acid.

By using one part of acid and 40 parts of water and leaving the cloth one minute in this bath, a very good white is produced.

By reducing the strength of the acid still further to produce a white, the goods must be left a longer time in this discharge beck.

To take off the oxide of lead the goods must be passed through hot water.

In adding to the minium other pigment colors (vermilion, green, ocher, chrome-orange, brown, etc.) and thickening with albumen, a variety of discharge colors can be obtained.

It is necessary in this case to steam before passing through the acid, in order to coagulate the albumen and fix the colors.

In passing through sulphuric acid or oxalic acid, or any other acid, the minium is transformed into peroxide of lead, which does not discharge well. The disadvantage of the new process is the difficulty to remove the lead chloride formed on the cloth. Even after passing the cloth through boiling water there is sufficient lead left to dye yellow in a bichromate of potash solution.—*Bulletins de la Société Industrielle de Mulhouse.*

CHAMPAGNE LIQUEURED WITH HONEY.

ONE of the principal cares of the champagne merchant is so to blend and liqueur his wines as to render them acceptable to his customers, whether they be English, American, French, German, or Russians, as these, in their different tastes, may be considered types of the champagne consumers of the world. The question commonly asked, especially by merchants and consumers in this country, is, "What is the percentage of liqueur in your wine?" and upon the answer to that question depends frequently whether an order be given or not. Thus one customer prefers the wine almost *brut*, another thinks that champagne is at its perfection with two per cent. of liqueur, a third is never happy unless his wine contains at least five per cent., while for some ten, twelve, and fifteen per cent. of liqueur is nothing uncommon. Of course the more sugar that is added the more completely is the origin of the wine obscured by the addition, and the greater will be the degree of effervescence when the cork is drawn. There is another point to be attended to besides the quantity of sugar employed—that is its quality. Hitherto it has been the custom of pretty nearly all manufacturers of champagne to employ only the very best white sugar or sugar candy that can be obtained. Now we hear that a firm at Reims have abandoned the use of sugar altogether in favor of honey, and they believe that this innovation is likely to produce a better wine than the ancient method. It is asserted that by the means thus used to obtain perfect purity the honey leaves behind it in the wine no trace of its origin. With regard to this system of liqueuring, it must certainly be said for it that it has the merit of novelty, even if in practical use it may not be generally followed, or, when followed, be found to be of no particular advantage. Still, if the statement be accurate that the honey leaves behind no trace of its origin, it has a certain advantage over other kinds of sacchariferous substances, and may lead to useful results.—*London Grocer.*

VISION OF COLORS.

By E. CHEVREUL.

THE author treats of the influence of his laws of the simultaneous contrast, the successive contrast, and the mixed contrast of colors, and gives instances of their application. He mentions that if gray or white designs are to be produced upon a colored ground, it is necessary to add to the gray or the white a trace of the color of the ground to prevent the appearance of its complementary color. In an experiment with revolving disks, painted half smoke-black and half white, the colors being divided by a diameter, on rapid motion the whole appeared of a uniform gray, but on slow motion the white took a yellow shade with a cast of red, and rising from the 1st to the 7·5th, and even to the 8th tone, while the black certainly took a blue-violet shade.

RESTORING FADED WRITINGS AND PAINTINGS.

M. VON BIBRA, in the *Journal de Chimie*, describes a method of restoring the writing of old manuscripts and the colors of oil paintings which have faded or become discolored by age. For the manuscripts, the writing is treated with recently prepared ammonium sulphide, and in the course of a few moments the characters become distinctly visible. Any excess of the reagent must be removed by washing in cold water, and the manuscript is then dried, either by gentle heat or by means of blotting-paper. Should the characters fade again after this treatment, they should be submitted to the action of a solution of tannin. As it is only in far distant times that carbon writing fluids were used, and as nearly all the more recent manuscripts have been written in gallate ink, it may be said that M. Von Bibra's method can be employed with any writings. For the oil paintings, after having dusted them with a wash leather, they are washed with a sponge and fresh water; they are then covered with a solution of soap (the author recommends shaving soap—probably that which is known in France as *crême de savon*), which is wiped off with a brush after the lapse of from eight to ten minutes, and when the soap has been completely removed the painting is allowed to dry. It is then rubbed with a soft linen cloth soaked in nitro-benzine, which restores the luster. Lastly, a little olive oil is passed over it, and it is varnished with a white varnish.

THE MODERATOR ELECTRIC LIGHT.

A GRAVE defect in the general principle of electric lighting, which has hitherto proved an insuperable barrier to its appliance to the purpose for which coal-gas is at present employed, has been the impossibility of dividing the electric circuit so as to produce a series of lights from one main source. This subdivision of the electric current has long been the cherished dream of many who have addressed themselves to the subject, and hitherto it has proved but a dream. Of all those who have endeavored to solve the problem, four only, as far as we are aware, have hitherto come prominently before the public with even approximate results, and, singularly enough, they were all Russians. Still more singular is it, perhaps, that a fifth *savant* of the same nationality has recently attempted its solution, and, so far as present experience has shown, has been eminently successful in effecting his object, as we shall presently explain.

The first to attempt the subdivision of the electric current was M. Lodyghin, of St. Petersburg, who some years since electrically burnt fine carbon rods *in vacuo* out of contact with the oxygen of the atmosphere. The result, however, was failure, owing to the circumstance that, by subdividing the light, M. Lodyghin greatly decreased its illuminating power. Later on, namely, in 1874, MM. Kosloff and Konn, both of St. Petersburg, worked out M. Lodyghin's idea with improved details and with considerable success as far as experiment went, as reported by us at the time. We are not, however, aware that the invention ever proceeded beyond this phase.

Still more recently—only last year, in fact—another Russian gentleman, M. Paul Jablochkoff, demonstrated the practicability of subdividing the electric current. This he does by employing what he calls an electric candle, which governs the electric light and supersedes the clockwork lamp. This candle consists of two pencils of carbon connected together side by side, and at the same time insulated by a strip of kaolin. The light is generated by a magneto-electric machine, producing alternating currents of positive and negative electricity. In this way M. Jablochkoff succeeded in lighting up, first, his own workshops, then the Marengo Hall in the Magasins du Louvre, Paris, and afterward a portion of the East and West India Docks, as reported by us at the time. The system is one of considerable promise, and is still in use experimentally in Paris. But, like those by which it has been preceded, it has its practical defects, although they are not of quite so serious a nature as those to which the others were subject. Among these drawbacks is the break in the continuity of the light, which necessarily occurs when the consumed carbons have to be replaced by new ones.

It is true that M. Jablochkoff has a very neat switch arrangement by which the consumed carbons are removed and replaced very rapidly. But there is a limit to the length of the carbons, as well as to the number the holder will carry. Besides this, if the light is extinguished, and this occasionally did occur during the experiments in London, it can only be reinstated by connecting the two carbons of the candle together with a needle of the same substance. Moreover, if one of the electric candles in a circuit is accidentally extinguished, the whole series in the same circuit suffer extinction. Again, for supplying the source of light, this system requires a special machine producing alternate currents, the ordinary machines with continuous currents being useless here as generators of light. But the most serious defect in the Jablochkoff candle is that the insulating substance which is placed between the two carbons—the kaolin, in fact—robs them of a very large percentage of their illuminating power. This can only be accounted for by the fact that the insulating material, when heated, really becomes a conductor of electricity, abstracting a portion of the current from the points, and thus greatly reducing their effective illuminating power.

All these and a great many more considerations of a similar practical nature presented themselves to the mind of a fifth Russian gentleman, M. J. Rapieff, who has of late been investigating the subject with the view of eliminating the defects of the Jablochkoff and other systems to which we have referred. His main object was to produce an absolutely fixed point of light in connection with a subdivision of the electric light, securing perfect continuity of illumination irrespective of the necessary changing of the carbons or of the accidental interruption of the current. Having recently paid a visit to the Electric Lighting Works, 19 Middle Street, London, where we carefully examined M. Rapieff's apparatus and its working, we are in a position to state that he has succeeded in accomplishing his object in a highly scientific and practical manner.

The light is produced from two pairs of carbons placed one above the other, the upper pair being inclined toward each other in **V** form, and the lower similarly inclined, but in **Λ** form, the points of ignition being the junction of the two points of the **V**'s. The lower pair, moreover, is placed at right angles with the upper, so that seen in plan they would form a cross. They can, however, be placed in any other relative position without in any way interfering with the results. The carbons at present used are 18 inches long and of varying diameters, according to requirements. They are carried in fixed holders, so arranged that the points of one pair are always approaching toward those of the other pair. The carbons are kept in juxtaposition by means of a fine endless cord, on which is suspended a weight, the cord passing over a small pulley attached to each holder. It is so adjusted that every part is in equal balance or tension, and the descending weight draws the carbons together, following up their consumption in the most precise manner. The carbons are free to slide through their holders, either small friction pulleys or copper-wire brushes being used to facilitate their forward movement and to insure their exact position at all times. The pulleys also act as conductors of the electric current. The top holder is capable of adjustment, by means of a set screw, for increasing or diminishing the length of the voltaic arc, according as there is a greater or lesser number of lights in the circuit, several lights requiring, of course, a smaller arc, or, in other words, more closely-placed carbons, than a single one.

Having once determined and fixed the length of the voltaic arc, the distance invariably remains the same until the carbons are consumed, unless anything occurs to interrupt the current. Should the current, however, be broken or interrupted from any cause, another beautiful arrangement comes into operation, by means of which the light is instantly restored. Its continuity, indeed, can hardly be said to have been broken, so inappreciable is the time between the extinction and reappearance of the light. It is, in fact, a mere wink of the light. The lower carbon holder is itself a small electro-magnet, which, while the current is flowing freely and uninterruptedly through to the carbon, is held up to an armature fixed over it at the opposite end to that at which the carbon is held. Intermediately between these two points the arm of the holder is pivoted to the framing of the apparatus, and the holder is capable of a slight play on this pivot similar to the motion of a scale beam. Upon the current being momentarily interrupted, contact between the rear end of the holder and the armature is broken, and the front end of the holder, with its carbons, is instantaneously drawn upward by means of a small spiral spring, and the carbons making contact the light is instantly re-established.

This re-establishment of the current of course causes immediate contact between the electro-magnet and the armature, and the voltaic arc is again fixed. By means of this ingenious and exceedingly simple self-acting arrangement the light is made practically continuous, and the necessity for all complex clockwork arrangements entirely avoided. The currents are led from the wires up rods, the positive to the upper pair of carbons and the negative to the lower pair. By having the positive current at the top, and the negative at the bottom, the light is thrown downward, owing to the concavity of the burning surface of the upper carbon point. By reversing the currents there is a reverse result, the light being thrown upward. The change of carbons is effected without in any way interfering with the continuity of the light. It will be remembered that four carbons are used, so that by withdrawing one at a time when nearly consumed, and replacing each by a fresh one, no interruption whatever is caused in the illumination. Another point gained by the use of four carbons in the moderator system, as against two in ordinary, is the production of a continuous light for double the length of time any other system will give, without change of carbons, the carbons being, of course, of the same dimensions in each case. The light from the carbons is transmitted through opal-tinted glass globes, and a steady, bright, but not by any means intensely brilliant light is diffused around. There is also an absence of those dense black shadows so generally caused by the electric light. In short, a useful and agreeable light which can be moderated to suit all circumstances is produced.

It will thus be seen that, so far as the science of electricity combined with that of mechanics will at present permit, we have here a very perfect system of electrical lighting. Upon the occasion of our visit to the works the workshop was well illuminated by one light, and the adjoining office by another. Two more lights were added to the series during our visit, making four in all, and showing the perfect subdivision of the current. The current was produced by one of the smallest Gramme machines, by which the number of lights was consequently limited; with a larger machine the number could have been increased. Individual lights were extinguished and reignited without in any way interfering with the others in the series. In short, all we have stated as capable of being effected with the moderator light was clearly demonstrated. To sum up its advantages, we may observe that it possesses simplicity of construction, which means economy in first cost, while it is stated that the economy of working will be very great over other systems. The lighting point is absolutely fixed, and perfect divisibility of light is attained in conjunction with absolute continuity. There is no limit within reason to the length of the carbons, and they are easily removed and replaced without interruption to the light, so that the moderator will practically burn for an unlimited period and with perfect steadiness.

Such is the most recent phase of the important question of electrical illumination which has been brought into its present practical condition by M. Rapieff. Its development, however, is being effected under the immediate auspices of Mr. E. J. Reed, C.B., M.P., who some years since made a very complete study of electricity and electric lighting. Having become acquainted with M. Rapieff's inventions in this direction, Mr. Reed made arrangements with him to put them into practical shape. This has been done under the detailed management of Mr. R. Applegarth, whose name is not unknown in connection with the subject of electrical lighting. Now that exhaustive experiments have established the practical value of the moderator light, it is Mr. Reed's intention to take steps for establishing this system of electric lighting in this country. It is, therefore, probable that before long the public will have an opportunity afforded them of passing an opinion upon the merits of an invention which, so far, holds out very great promise of being a scientific as well as a practical success.—*London Times.*

INDUSTRIAL APPLICATION OF SOLAR HEAT.

By M. MOUCHOT.

THE author has first endeavored to ascertain what metals are best adapted for reflectors. He gives the preference to brass, upon which a thin layer of silver has been deposited by galvanism. The daily variations of heat, with a clear sky, are not very sensible between 8 A.M. and 4 P.M. The intensity of the heat collected is satisfactory between 6 A.M. and 7 A.M.; it increases rapidly from 7 P.M. to 8 P.M., and decreases between 4 P.M. and 6 P.M. The quantity of heat collected at Algiers per minute per square meter was 7 calories in April, 8 in May, and 8·5 in June and July. A yield of 7 calories proves that a reflector of a square meter would boil in less than 12 minutes a liter of water at 20°, and give hourly 1,322 liters of steam at the normal pressure. These results are only two-thirds of what may be attained with receivers of larger size. The author thinks that he has succeeded in popularizing the small solar apparatus suited for cooking food, baking bread, distilling alcohol, etc.

ASTRONOMY.

[Royal Astronomical Society, Prof. CAYLEY, Vice-President, in the Chair.]

PROF. ADAMS explained on the blackboard a remarkable property which he had discovered, of the analytical expression for the constant term in the reciprocal of the moon's radius vector, or what is commonly called the constant term of the moon's horizontal parallax.

Captain Tupman read a paper upon the measurement of the photographs of the transit of Venus. The photographs of the English Government expeditions have all been taken with similar photo-heliographs, made by Dallmeyer. The image of the sun has been enlarged by secondary magnifiers to 3·9 ins. in diameter, and a series of measurements has been made to determine the distortion of the photographs at the parts of the plates where the limb of the sun and the limb of Venus fall. The results of these measurements show that there is very little difference in the distortion of the different instruments. The photographs of the transit were then taken and marked by Mr. Burton and Captain Tupman independently, with lines indicating the direction of the diameter joining the center of Venus and the center of the sun, and in this they found that there was hardly any perceptible difference between their two estimates; but when they came to measure the distances between the centers the discordances between Mr. Burton and Captain Tupman were so great that it was evident that their measures would be quite useless for the purpose of determining the sun's distance.

The Astronomer Royal said all the preliminary investigations for determining any constant source of error in measuring the photographs were very carefully carried out. The errors of a scale of millimeters, which was made for us by Mr. Simms, for measuring the photographs, were very carefully determined, and the distortion of the photo-heliographs was also determined by means of a scale of equal parts 16 ft. long, which was lent to the Observatory by Mr. De La Rue; this was photographed in various positions, and the photographs were then measured with the millimeter scale. So far everything went well, but when we came to measure the photographs of the transit I must say I was grievously disappointed. When I was officially called upon to express my opinion on the propriety of incurring the expense of the photographic work, although, as I then stated, I had some doubts about it, yet I expressed myself favorably to it, and I hold myself responsible in some degree for having incurred so much expense and labor. But I can only say that the results have been most disappointing. The images are very troublesome, partly owing to difficulties arising from irradiation, and partly to other causes, one of which is the very excessive brightness about Venus, which makes it look somewhat like a hat with a brim round it, and another is the excessively gradual degradation of light at the limb of the sun. When the measures were made there was some doubt as to the scale to which they ought to be referred; the scale I adopted as the best I could get was to take the sum of the measures of the diameter of the sun and the diameter of Venus, thus getting a quantity affected by two opposite kinds of irradiation, for the diameter of the sun is increased by the irradiation action, while the diameter of Venus is diminished by it, and we might suppose that the two opposite effects would annihilate each other, but it appears that they do not, and no doubt this is one of the sources of uncertainty. By means of the eye-observations Captain Tupman, after a most careful discussion, fixes upon something like 8″·83 (I will not answer for the one-hundredth part of a second), but from the reduction of the photographic measures, treated as well as we can, we get a parallax of 8″·2, a parallax which would be utterly irreconcilable with the eye-observations, and I do not see at the present time any sufficient explanation of the great difference.

Mr. Common asked whether the distortion determined from photographs of a scale at a few hundred feet distance would not differ from the distortion when the instrument was focused upon celestial objects.

Captain Tupman said that the focusing was done by moving the object-glass; the lenses of the eye-piece or magnifying apparatus had not been disturbed since the photographs were taken, and consequently he thought the distortion determined from photographing the scale might be relied upon.

Mr. Ranyard read a paper by Prof. C. A. Young on his observations of the transit of Mercury, made at Princeton, America. Prof. Young had not been able to see any trace of a ring round the planet, or spot upon the disk. The structure of the photosphere in the neighborhood of the planet was very carefully observed, and Prof. Young fancied that the rice grains in the neighborhood of the limb appeared to be lengthened out radially, which was just the contrary effect from that which might be expected if the planet was surrounded by a refracting atmosphere, and he was inclined to think that the phenomenon was wholly subjective. The color of the disk, when viewed with a Merz polarizing eye-piece, appeared violet, exactly similar to the color of the nuclei of sunspots.

Mr. Ranyard read a letter from Mr. Prince, of Tunbridge Wells, calling attention to an observation which he had made in the year 1867, and which he had described in a letter to the *Astronomical Register* of that year. The planet Mercury was at the time near to its greatest elongation, and on examining it in the daytime with a 5-in. refractor he had seen a bright spot a little to the south of the center of the planet. A friend in the neighborhood, whose attention he had called to the phenomenon, had also seen the bright spot with another instrument.

Mr. Christie read a paper on the bright lines or interspaces between dark lines in the solar spectrum in the neighborhood of the G line, which have been attributed by Prof. Henry Draper, of New York, to the presence of oxygen in the sun. Mr. Christie showed a drawing of that part of the spectrum which he made with the Greenwich half-prism spectroscope. He found that, when this region of the spectrum was examined with high dispersion, the bright lines appeared very broad, compared with the dark lines, and that they did not appear to degrade at the edges, as might be expected if they were really bright lines, and not parts of the continuous spectrum cut out or left by dark lines. Besides this, he found that there were certain fine dark lines toward the middle of each of the bright lines or spaces. This, he thought, rendered the hypothesis that they were bright lines still more difficult, as one would have to assume that the oxygen lines were each double, and were only separated by a very fine sharply-defined interspace. Another point to which he wished to draw attention was that since there were no dark lines in the solar spectrum which corresponded with lines in the spectrum of oxygen, it was evident that the lines of the oxygen spectrum must all fall upon interspaces between dark lines, and, therefore, no weight ought to be placed upon the mere fact of their coincidence with interspaces between dark lines.

Mr. Ranyard said that the identity of any series of lines in the solar spectrum with lines in the spectrum of a gas could never be absolutely determined. We should be nearer the truth if we spoke with greater accuracy, and said with such and such a dispersion the lines of such and such an element appear to be coincident with such and such of the solar lines. We might find, on making use of a larger dispersion (as had actually been found in the case of the 1474 line, which was at first supposed to coincide with one of the iron lines, but was now found to be distinct from it), that there was a slight difference in the place of the lines, and that their centers did not accurately correspond, but this is not what Mr. Christie had shown; he had not examined the spectrum of oxygen with a high dispersion and shown that the centers of the oxygen lines did not correspond with the positions of the centers of the bright bands. It was not necessary that lines which did not correspond with the dark lines should all fall upon and exactly coincide with the interspaces; they might, and if taken at random the probability was that they would, partly overlap such interspaces and partly overlap the dark lines. But according to Dr. Draper's photograph, which unfortunately was not on a very large scale, the ten or eleven bright lines of oxygen there shown appeared to co-

incide centrally with the interspaces, and, more than that, they appeared to agree in relative brightness. He thought, therefore, that in speaking of the agreement of these lines in the solar spectrum with the lines of oxygen we ought to treat it as a matter of probability, and if, with any particular dispersion, the chances of a central or apparently central coincidence of any line with a line of the solar spectrum were x, then the probability of the coincidences of the ten lines of oxygen with the ten solar lines or interspaces would be measured by x^{10}, multiplied by something else, which would measure the probability of the observed similarity in the relative brightness. This was all that had been made out with regard to oxygen, and Mr. Christie had not shown that there was not this coincidence. With regard to the theoretical objection, that a gaseous atmosphere overlying a continuous spectrum must absorb its own wave length, and give rise to a dark line, there was the remarkable case of the D_3 line, which was seen bright in the chromosphere, but yet there was no equivalent dark line in the solar spectrum. There was also the 1474 line, which, though the brightest of the corona lines, had only a faint Fraunhofer line corresponding to it, showing that the law of exchanges did not universally hold. This was also proved by the bright lines of gaseous nebulæ, for if the law of exchanges held absolutely true, the outer and cooler layers of a nebulous mass would absorb all the wave lengths emitted by the gas in the interior of the nebulæ.

Dr. Schuster said that none of the bright lines of oxygen were sharp lines, but the fact which had been pointed out by Mr. Christie, that the bright bands near G did not fade off at the edges, looked very much against their corresponding with the lines of oxygen. He had himself shown, in a communication to *Nature*, that there was another spectrum of oxygen, and that there were dark lines in the solar spectrum which corresponded to it; he did not think it was probable that oxygen would be present in the sun in its two forms. With regard to the theoretical difficulty, he did not think that the question was so simple as Mr. Ranyard had put it. In the nebulæ there was no background of continuous spectrum to be absorbed; the only way in which you could get bright lines in the sun without corresponding dark ones was by assuming that hot matter was thrown up from the interior. If you considered the sun as a body at rest, no thickness of layer of any gas or metal would produce a bright line.

Mr. Knobel exhibited a chronograph tracing, made by the chronograph at the Naval Observatory at Washington. The remarkably accurate going of the clock, and the equable rate of the instrument, were shown by the absolute straightness of the line of seconds' marks on a sheet, corresponding to a period of two hours.

SCIATICA AND NERVE-STRETCHING.

EDINBURGH MEDICO-CHIRURGICAL SOCIETY.—Mr. Chiene introduced a patient on whom he had performed the operation of nerve-stretching for a severe, prolonged, and intractable attack of sciatica. The man, about forty years of age, can now move the leg freely, having previously been prevented from working for a period of nine months. The subject of nerve-stretching also received attention in a paper by Mr. Johnson Symington, M.B., in which he described experiments performed with a view to test the cohesion of nerves. Out of fourteen observations on the dead body, in which weights were rapidly attached to the great sciatic nerve immediately below the gluteus muscle, 130 lbs. was the average weight found necessary to rupture the nerve. The maximum, 176 lbs., was required to tear the nerve in the body of a strong muscular man, who had died rapidly from an injury to the head; the minimum, 86 lbs., in the body of a young female, aged eighteen, who had died from phthisis. Six gave way at the hook attaching the weight, while the eight others separated at the nerve-roots. Mr. Joseph Bell had performed the operation of nerve-stretching in a case of inveterate sciatica. After opening the sheath of the nerve and laying hold of the nerve with the finger, it easily came up as a loop, and, in pulling on the nerve from the point of origin, as well as from the distal side, the feeling he had was as if he was pulling a vegetable, with long fibrous roots, from the ground. He stopped short of lifting the patient from the table by his sciatic nerve. No paralysis supervened. Mr. J. Chiene had operated in five cases of severe sciatica. He does not lift the limb from the table by the nerve, and has recently simplified the operation by making an incision, one inch in length, externally at the angle made by the lower border of the gluteus maximus and biceps cruris. What was the essential pathology of sciatica? Thickening of the nerve-sheath was often held to be its cause, and in one case he had found the veins on the nerve to be varicose. Dr. Alex. Miller showed the instruments used by the natives of Japan in the treatment of sciatica. They consist of fine gold needles, which are thrust into the limb at the seat of pain, and left there for some time. Dr. Miller said that in the operation of nerve-stretching the carbolic acid used for antiseptic purposes might have to do with the good result. Dr. J. Duncan said it was Syme's practice to thrust the needles through the nerve and down to the bone, and leave them there for an hour and a half. Dr. G. Balfour had never failed to cure sciatica medicinally, and with help of acupuncture, or morphia or atropia injections.

THE SURGEON'S DUTY.

By M. VERNEUIL.

APROPOS of a little operation, which I am about to do on a young patient who entered our wards three months ago with a crushed hand, I must once more insist upon the course a surgeon ought to pursue in wounds of the hand. Whenever you shall have to treat a patient suffering from any crushing of the hand, adopt as an absolute rule to excise nothing and to trim nothing with a knife. In those cases the surgeon ought only to think of warding off and controlling primary complications; but he should leave to nature the care of saving whatever she can save; she will preserve more than the surgeon, and will always waste less. We do not sufficiently clearly conceive how much of the lacerated, and on the first day condemned, tissues may resume their vitality and be repaired. Allow nature then to act. Wait. Later, after weeks, or even months, when cicatrization shall have occurred, then only should the surgeon interfere and trim the wound in such a way as to procure for the patient the fullest use of the limb.—*Jour. of Med. Science.*

A PLANT named Hoang-nan is attracting much attention as a remedy for leprosy.

SLEEPLESSNESS—ITS CAUSES AND CURE.

By JAMES SAWYER, M.D. LOND., M.R.C.P.,

Physician to the Hospital, and Professor of Pathology in Queen's College.

I DESIRE to submit to you some practical observations, based upon my own experience as a physician, concerning the etiology and management of insomnia. Inability to sleep at all, or inability to sleep long enough, without the aid of drugs, is one of the commonest complications and consequences of a vast variety of morbid states. Pyrexia; physical pain, if sufficiently severe and from whatever cause arising; frequent coughing, as that which often occurs in chronic pulmonary phthisis; urgent dyspnœa, such as results from extreme dilatation of the cardiac cavities, and requires an extraordinary vigilance of the nervous centers for the maintenance of the process of respiration and circulation, are conditions which prevent or shorten sleep. In such instances the cause of the sleeplessness is obvious. The insomnia may mostly be controlled either by the exhibition of remedies which directly promote sleep (hypnotics), or by the adoption of measures which combat the cause of the insomnia, by reducing the fever, by palliating the pain, by checking the cough, or by relieving the cardiac disturbance. Of sleeplessness arising as the direct effect of these and similar causes it is not my purpose to speak. I shall endeavor to unravel the complex causes, and point out the successful treatment of that kind of insomnia which may be called, for the sake of simplicity, but not with strict truth, *insomnia per se*, or simple inability to sleep—a kind of wakefulness for which we mostly fail to find an obvious physical cause, and which seems to depend upon an inability on the part of the brain and nervous system generally to adapt themselves to the conditions which are necessary for sleep. We meet with this disorder more in private than in hospital practice—mostly in persons who belong to what is known as the upper middle class, and mostly in individuals of high mental endowment. The malady is of extreme importance, and happily, if its causes be rightly understood and judiciously controlled, there are few affections which are more within the sphere of curative therapeutics.

A close study of cases of the kind of insomnia of which I am speaking soon reveals striking differences between individual instances of the disorder, in respect both to the causes and the course of the malady. These differences demand careful consideration because they have important bearings upon both our therapeutics and our prognosis. I have endeavored to arrange the different varieties of insomnia into groups, in which the cause of the affection is the "principle of division." To these groups I give the names "psychic," "toxic," and "senile."

In natural sleep the brain is relatively anæmic. When the organ is in full activity its arteries are filled with blood; its cells are living rapidly, actively receiving nourishment from the blood, and pouring into it in exchange the *effete* products of their vitality. But in sleep the brain is inactive, at least all but that part of it which is concerned in the processes of organic life. The cells which think are as still as those of the muscles of a limb which is at rest. The blood flows in a smaller and gentler stream than in the waking state; the cells are not expending energy, they are leisurely renewing it and storing it up—in a word, they are resting. Any cause which prevents the due repose of a sufficient number of those brain-cells which are concerned in conscious thought will prevent sleep; relative cerebral hyperæmia is a consequence of such activity, and is also a concurrent, though subordinate, cause of wakefulness. Hence there are causes of insomnia which act primarily in sustaining cerebral activity, and with it, and in consequence of it, relative cerebral hyperæmia. Again, any cause which prevents the brain from becoming sufficiently relatively anæmic for sleep will produce insomnia.

Any agent which sustains cerebral hyperæmia, or any morbid condition which impairs the contractility of the cerebral arteries, may prevent, wholly or in part, the occurrence of such a degree of cerebral anæmia as is required for the production of sleep. Hence there are causes of insomnia which act primarily in sustaining relative cerebral hyperæmia, and with it, and in consequence of it, cerebral activity. But in such a complex condition as conscious cerebral activity, where thought implies increased blood-flow, and increased blood-flow implies thought, we cannot in any given case allow, with strict accuracy, entire causal precedence to either of the factors which are essential to the common result. These considerations are strictly pertinent to a clear conception of the causes of insomnia. In some cases of sleeplessness, as in the psychic group, undue cerebral activity is the primary vice; in others, as in the toxic and senile varieties, relative cerebral hyperæmia is the initial error, and cerebral activity its direct consequence.

I shall now consider more particularly the psychic form of insomnia. A severe and sudden emotional shock of a depressing kind—as grief at the death of a child, a parent, or a wife—will sometimes induce at once persistent insomnia, which will only yield to carefully directed therapeutic procedures. Prolonged mental strain, in all its varied phases, is a common cause of sleeplessness. Our patient may be a student preparing for an examination. For weeks, in spite of fatigue, he may have shortened his hours for rest that he might lengthen his time for reading; and he may have roused his brain to wakefulness, when it would readily have fallen asleep, by drinking strong tea or coffee, or by smoking tobacco. But he could always go to sleep at once and sleep soundly when he went to bed, until, after some weeks of abnormal work, with the nearer approach of the examination bringing increased anxiety as to the result of the ordeal, he found that he began to sleep badly or could not sleep at all; he grew miserable; he could not remember what he read; he felt unfit for any exertion, and he found that he could not face his examination.

Or our patient may be a young professional man. He has commenced practice, or rather to wait for practice, as a barrister, a solicitor, a surgeon, or a physician. He begins to find that clients or patients are not ready made and waiting for his advent. For a time he struggles on, his hope and his health sustaining him; but these at last yield under the continued pressure of new disappointments and accumulating anxieties. He wants money; his friends will give it to him readily if he will ask for it, but his pride prevents him. It is not a gift or a loan he needs; he does not want to beg or borrow money; he yearns to earn it. And all the time while he has been hoping and waiting, and growing sick with the failure of his expectations, he has been working early and late in his study, denying himself due sleep and exercise, in the trust that he might thus so skill himself as to secure the longed-for practice. At last he has fairly broken down. He has grown thinner; he looks haggard; he is filled with groundless fears; he has constant headache and noises in his ears; he thinks his memory is failing; he is dull and listless; he has begun to sleep badly; he has been lying awake for hours after going to bed, and when he has slept he has had horrid dreams; and he comes to us for help because he can scarcely sleep at all, and he feels he is going mad.

In these cases acute or continued mental strain is the primary cause of the sleeplessness. Where the shock has been sudden and severe, it has been sufficient to rouse a given group of cerebral cells into persistent activity. Where the strain has been less intense, but long continued, it has been all the more hurtful, because the same set of ideas has been maintained in exhausting recurrence, and because, as a consequence of this monotony, the same part of the brain has been kept continuously upon the rack. But in either case sleeplessness did not occur until there arose from exhaustion partial or complete vaso-motor paralysis of the intracranial bloodvessels—until the arteries of the brain, worn out by a sustained erethism, could no longer, even when the brain most needed it, find the force for that contraction of their caliber without which sleep is impossible.

The subjects of the psychic form of insomnia are mostly men, and mostly men of the nervous temperament. We have lately been too apt to ignore temperaments; our fathers studied them better, and regarded them more than we do. But I shall not go to any authority for a portrait of the nervous temperament; I shall describe it as I think I have found it. I use the phrase nervous temperament as indicating a distinct type of outward form, of manner, of habits, and of tendencies. Temperaments present their strongest types most commonly in men; few women exhibit a well-marked temperament. Two or more of the different kinds of temperaments may appear to be blended; we may have a modified, a tempered temperament. A man of distinctly nervous temperament has a quick manner; if he do not know us well, he fidgets with his hands or legs when he is talking; he speaks abruptly, earnestly, and loquaciously, and he frequently recalls his statements to correct them, splitting up his phrases and modifying his adjectives in his anxious desire to express the finest shades of truth. When he becomes a patient he is harassed about some trivial symptom; he has felt his heart beating, and he fancies he has some deadly cardiac disease; he thinks his memory is failing, and he fears he is going mad.

A man who has suffered much from insomnia becomes the subject of a well-marked group of symptoms. Most of them are given by certain writers among the signs of cerebral hyperæmia. It is probable that they mark what may be called irritable exhaustion of the brain, attended by more or less abnormal increase of intracranial vascularity, and accompanied by some general prostration of the bodily powers.

Here are the signs as I have found them. The patient has a dull and listless look; his eyes are wanting in vivacity; the upper lids may droop a little, and they may appear slightly swollen; his complexion is sallow. He complains of headache. This is of two kinds, which may coexist or occur separately; the commoner is a dull pain felt over the whole of the vertex, together with a vague and widespread feeling of oppression in the head; the other is a sharp, shooting pain, which comes on suddenly in single flashes, and which gives the idea of a knife being driven through the head from one temporal region to the other. Occasionally the patient feels a momentary sense of giddiness; this may cause him to make a false step, but it never lasts so as to give rise to staggering. The skin of the head, especially in the neighborhood of the sagittal suture, may be tender. There are noises in the ears, in one or in both, and which are more or less persistent. They may come on suddenly, and without apparent cause, as when the patient is engaged in quiet conversation, or they may only occur when the attention is closely occupied, as in writing a letter or casting-up figures. These noises are usually of a low-pitched whistling character.

A striking sign is a slight impairment of hearing. The patient may be unaware of it, but those who live with him have noticed that he often asks them to repeat what they say to him, because he could not quite catch their words. He may complain of seeing spots before his eyes, little cobwebby black lines which come and go and float about, or bright, bluish, phosphorescent-like specks which are fixed one before each eye, and which only appear when he first directs his eyes toward an object. There are some abnormal sensations in the skin; not a feeling of formication, such as often arises in organic nervous disease, but a sharp, transitory and isolated prickling, as of the movement of a single pin, which endures only for an instant, and affects either the limbs or the trunk, mostly the former. There may be a peculiar twitching of muscles. It is not a vibratory tremor, such as occurs in progressive muscular atrophy, nor is it a contraction of a whole muscle, or of a group of muscles, such as arises in true convulsion. But, while the patient is sitting still, and wholly independently of his will, a considerable part of a muscle becomes the subject of rapid clonic movements.

These movements mostly occur in the lower extremities, but they are rarely sufficient to move the limbs; they usually affect the lower part of one vastus internus, and last for about a minute. The patient can feel the movements directly by simply attending to the affected part, and he can also feel that the muscle is moving by applying his hand to it. In such a case there is often unnatural and painful sensitiveness to external impressions. The patient craves for quiet. A bright light troubles him. Noises, the sight of moving objects, touches (as of the hand of a friend upon his shoulder), annoy him. There is not an increased sensitiveness to external impressions, but impressions which are enjoyed or unnoticed in health become irritants.

In toxic insomnia, the cause of sleeplessness acts primarily upon the vessels of the brain, giving rise to some degree of arterial hyperæmia. A poisonous agent maintains cerebral vascularity at such a height that conscious cerebral activity—that is, wakefulness—is an inevitable consequence. Such a poison may be introduced into the body from without, or it may be a product of diseased processes arising within the body itself. Of course I use the word "poison" in a restricted sense; I do not mean something which kills, but only something which produces abnormal manifestations in the living body. The external poisons which most frequently cause sleeplessness are tobacco, alcohol, tea, and coffee; the internal, certain effete products of tissue-metamorphosis which accumulate in the bodies of gouty persons or of those whose kidneys act deficiently. Many a man does not and cannot sleep sufficiently because he smokes excessively. Cut off his cavendish or his cigars and he will sleep well. Many smokers know that they sleep badly if they smoke more than their usual quantity of tobacco, or if they smoke stronger tobacco than that to which they are

accustomed. If a man who smokes two cigars every evening is induced at some time to smoke three, or if a smoker of bird's-eye ventures to replace it by cavendish, he may, when he has gone to bed, find he cannot sleep; and the cause of his sleeplessness is the smoking of more or of stronger tobacco than by habit he has hitherto borne without discomfort.

Men of distinctly nervous temperament, or men in whose temperament there is a distinct and considerable admixture of the nervous element, are usually the largest smokers. Men who are slow and calculating are rarely smokers; men whose activity is of an objective type are happy in rarely feeling the nervous unrest which tobacco calms. Tobacco-smoking stimulates the cerebral circulation; it disposes to a succession of pleasing ideas by inducing an easy flow of mental activity. But this stimulation of the blood-flow in the brain is sure, if pushed to undue limits, to induce cerebral vaso-motor debility or paralysis, and, as a consequence, persistent conscious thought. Sometimes, then, a man consults us for the relief of insomnia, and we find he is young, he has had no trouble, he takes plenty of food and exercise, and he does not overtax his brain. But he is an excessive smoker; he smokes morning, noon, and night, and he has gone on from the mildest tobacco to the strongest. He need not give up, or shorten, or change his work, and he surely does not need drugs; cut off or cut down his smoking, and he at once sleeps well. And so, *mutatis mutandis*, does alcohol cause sleeplessness. The man who drinks to commencing drunkenness mostly sleeps soundly, if not well. But many a so-called moderate drinker knows that he sleeps badly if he takes a little more than his usual quantity of wine after dinner, or even his usual quantity of some unusual wine. Alcohol flushes and dilates the smaller blood-vessels, especially those of the brain; if such a condition be maintained sleep is disturbed or wanting. We have all seen the insomnia of delirium tremens: the patient cannot sleep because the lesser arteries of his brain are paralyzed by alcohol, and sleepless cerebral activity is the inevitable consequence. Far short of what is usually called alcoholism, we often meet with cases of insomnia in which alcohol alone is the cause of the wakefulness. The patient may pride himself upon his moderate use of fermented stimulants, and he may be wholly ignorant of the cause of the sleeplessness for which he consults us. We fail to find any sufficient psychic cause for his insomnia; but if we take away or diminish his wine or his grog, or induce him to consume it before the evening, we find that he shortly begins to sleep well.

The effects of tea and coffee in causing wakefulness are well known. Some individuals are extremely susceptible to the action of these stimulants. We sometimes meet with persons, mostly women, who habitually drink enormous quantities of strong tea; such people are usually troubled with flatulent dyspepsia, and sleep badly, but they rarely suffer from serious insomnia.

On this occasion I can only mention those varieties of toxic insomnia which are apt to occur in gouty persons, or in those whose kidneys are failing, and which arise from the accumulation in the blood, in consequence of deficient excretion, of the products of tissue-metamorphosis. Insomnia of this kind is rarely complete. But the patient may complain that he sleeps very badly, that he lies awake for some hours and has great difficulty in getting off to sleep, that he is easily awakened and wakes frequently, and that he always dreams when he sleeps. In such a case we may find a pulse of high tension; the aortic second sound may be accentuated, and the first sound of the heart may be reduplicated at the apex. Where there is chronic renal disease, we may also find the direct physical evidences of the characteristic cardiac hypertrophy which accompanies chronic interstitial nephritis. I believe that insomnia in such cases is due to the maintenance of a state of high tension in the cerebral arteries. I wish to impress upon you that we find the clew to many cases of sleeplessness in the signs of the gouty diathesis or in the discovery of albuminuria.

Again, there is a senile form of insomnia. You may perhaps have observed among your friends that an exaggerated appreciation of the merits and value of early rising mostly increases as age advances. The sleeplessness from which many old persons suffer is mainly, if not entirely, the result of senile degeneration of the smaller cerebral arteries. Those vessels are less elastic and less contractile than in health, and their weakened walls often lead to their permanent dilatation; they are physically unable to adapt themselves fully to the condition of relative arterial anæmia which is requisite for healthy sleep. The tendency of this condition of the blood vessels of the brain to prevent or diminish sleep is probably to a great extent counteracted by the cardiac feebleness which so frequently and so fortunately coexists with the vascular changes.

In the treatment of insomnia we must often use soporifics. Of these the chief are chloral, opium, morphia, the bromides, Indian hemp, alcohol, and affusion with cold water. The successful treatment of a case of sleeplessness follows from the discovery of its cause. In the severe forms of psychic insomnia we must at once secure sleep by some efficient hypnotic. I prefer chloral. By its use alone we can often quickly cure acute insomnia depending upon some sudden mental shock or strain. A few nights of sound and sufficient sleep, artificially induced, will do more than anything else to restore to the brain the power of sleeping without aid from drugs. In the more chronic forms of psychic insomnia, where the sleeplessness or wakefulness usually depends upon prolonged worry or overwork, I employ chloral sparingly. It should only be used as a temporary remedy, when it is necessary that we should at once secure a fair amount of sleep. The patient ought never to be allowed to swallow this dangerous but valuable drug whenever he feels disposed, or to apportion its dose for himself; he ought only to take it upon the special prescription of his doctor. An overworked man must never be permitted to go on with his overwork, and habitually secure sleep by chloral or any other hypnotic. In such a case we must always aim at preventing the sleeplessness by removing its cause, instead of permitting that cause to continue and trusting to counteract its effect by medicines. When a man cannot sleep because he works his brain too much, we must insist that he stop or greatly diminish his work. But I must warn you that real work is rarely the cause of insomnia. Work fits for rest. It is mostly worry, not work, that brings unrest. It is not work that wears, but worry. A holiday, with complete change of scene, will often do much to effect a cure. The old maxim, *Cœlum non animum mutant qui trans mare currunt*, like many other maxims, old and new, is not always wholly true. Send an overworked and worried merchant or barrister from his counting-house or his chambers in a busy town to a quiet village by the sea, or across the channel to a French watering place, and let him substitute walking, and bathing, and rowing, and fishing for his books or his briefs, and he will often need no physic to make him sleep soundly and sufficiently. But many cases of psychic insomnia can only be cured with the aid of drugs. In the well-nourished, bromide of potassium is by far the best hypnotic. It soothes the irritated and irritable cerebral cells; it is a direct and absolutely safe brain sedative, and it is marvelously powerful in producing nervous calm. But it must be given in full doses, thirty to sixty grains at bedtime. It is well to conjoin with it some drug which will favor the contraction of the weakened cerebral vessels; for this purpose we may give tincture of ergot or tincture of digitalis, one or both. In many cases of chronic wakefulness, arising from mental strain, the patient is distinctly anæmic. Unless the anæmia be remedied the insomnia cannot be cured. The patient's pale face and compressible pulse declare the condition of his blood. Such a person mostly feels drowsy when he is up, and wakeful when he lies down. Of course he needs iron; we may give him a grain or two of reduced iron, sprinkled on a piece of bread, or a wineglassful of Orezza water, after each meal. His diet must be liberal, containing plenty of fish, meat, and eggs. For such a patient alcohol is often the best hypnotic. To many people a "night-cap" of toddy is a superfluous and hurtful luxury. But it can give, perhaps better than anything else, rest and sleep to the exsanguine and worried brain. We must never be blind to the responsibility we incur when we prescribe alcohol. When we use it as a remedy in the treatment of disease we must state distinctly the reasons for its adoption, and we must discontinue it, as we discontinue the employment of other drugs, when the conditions which called for its exhibition have disappeared. If I am sure of anything in therapeutics, I am sure that alcohol is the best hypnotic in many cases of chronic psychic insomnia when the patient is worried, sorrowful, weakly, and anæmic.

Many minor points are worthy of attention in the cure of chronic psychic insomnia. In most cases, whether he sleep badly or well, the patient ought, from day to day, to go to bed and get up at some fixed hour. Healthy sleep tends to occur periodically. Daily bodily exercise, short of great fatigue, must be enjoined. Riding in a carriage is good, walking better, riding on horseback the best of all. A worn and self-worrying man, wrapt up in the absorbing current of self-consciousness, may take exercise in a carriage or upon his legs and still keep up his fretting, but he must come out of himself when he gets into a saddle. Gardening, for those who live in the country, affords good exercise, and is very efficient in keeping up objective attention. Those who live in towns may find good objective employment in chopping wood; if they have not trees to fell, they can at least copy Archbishop Whately, and give their minds a refreshing objective turn and their muscles healthy work by cutting up firewood. People who find it difficult to get off to sleep are sometimes advised to diligently and monotonously count one, two, three, up to a thousand or more, until they fall asleep; to watch in imagination each one of a large flock of sheep squeezing through a narrow opening; to picture some familiar landscape and keep the mind fixed upon it; to repeat the letters of the alphabet, etc. These are expedients for changing the current of cerebration. For a night or two one or the other may succeed, but they cannot be relied upon. These practices often even keep up wakefulness; when the mind attends closely to them they perpetuate the subjectivity which keeps the brain from resting. Very often the surest way of keeping awake is to try hard to get to sleep. We do most things best when we forget ourselves; going to sleep is no exception to the rule. When the contractility of the cerebral arteries has become much weakened by prolonged thought, and when, as a consequence, there is wakefulness, sleep may often be induced by the temporary application of cold to the general surface of the body. A person who has been lying awake will often fall asleep at once after getting out of bed and sousing his head, neck, and hands in cold water, or after (following Charles Dickens's plan) standing at the bedside until he feels chilly, and turning over, shaking up, and cooling his pillows and the bed-clothes.

Just a word about the treatment of the other varieties of insomnia. In the toxic kinds we take away or diminish the tobacco, the alcohol, the tea, etc., as the case may be. *Cessante causa, cessat et effectus.* A discussion of the treatment of gouty insomnia and of the sleeplessness arising in some chronic renal diseases would involve a consideration of the whole question of the therapeutics of the maladies upon which these forms of wakefulness depend. I shall only say that in gouty lithiasis, with a pulse of high tension, I have confidence in the curative effects of colchicum, supplemented by the exhibition of dilute saline purgatives, such as Pullna, Friedrichshall, Hunyadi Janos, or Rakoczy waters. Senile insomnia is very obstinate; perhaps in the bromides, with full doses of hop or henbane, we have the best and least harmful means for its relief.—*Lancet.*

CURARE IN EPILEPSY.

By Dr. C. F. KUNZE.

MY experiments with Curare (Woorara) in 35 cases had very different results. Nine of the 35 cases made a perfect recovery. In most of them the disease had not been existing for a long time, say one, three or five years; in two of the successful cases the patients had been epileptic subjects for over 20 years. Among those who recovered there were some cases in which the disease had produced a well defined influence on the mental condition of the patients. Two of the cases which recovered were undoubtedly cases of inherited epilepsy; the history of these (brothers) is given below. I could obtain no good effect in old drinkers. My experience with Curare leads me to say that *Curare is one of the most efficient remedies for epilepsy.* A case of epilepsy should not be regarded as permanently cured until a long time after the occurrence of the last attack. A short time ago I saw the return of the disease after an apparent recovery, extending over a period of 4 years.

I make a solution of Curare according to the following formula:

℞ Curare..............grs. viiss. (7½)
Aquæ dest............ ....m. 75.
Acid. hydrochl. pur..........m. i

hypodermically, and I inject about 8 drops every five or six days.

The addition of this small amount of hydrochloric acid makes the solution a clear one, and by this slight modification of my former formula I have avoided almost entirely the severe abscesses at the point of injection.

History.—Edgar and Hugo Ufer are the sons of a subaltern officer in the Internal Revenue Service at Botterfield, Prussia. The father sustained a severe injury on the head, when, in 1846, during his service as a soldier he tried to stop the runaway of four horses attached to the carriage of the late King Frederick William IV. of Prussia. He was thrown down, dragged along for a distance and received a kick on the head by one of the four stallions. In consequence of the injuries brain symptoms developed, and the man suffered for over a year from convulsions and very severe headache. Five or six years later the injured man married and became the father of two sons, both of whom were attacked with epilepsy, one in his 18th and the other in his 13th year.

Hugo, the elder of the two brothers, is now 25 years of age, and of sickly constitution. The first attack occurred July 6th, 1871, lasting for about one minute; another attack of somewhat longer duration took place the next day, being followed by three attacks on July 9th, occurring with intervals of from four to five hours. July 10th, again, three attacks; July 11th, a light, and three-quarter hour afterward a severe attack, lasting for about fifteen minutes. This last attack commenced with a disposition to weep, dizziness in the head, followed by a sudden unconsciousness. After the attack was over, there was a sensation of numbness over the entire body, the speech was heavy, the patient felt very tired and suffered from very severe headache. From July 11th to July 16th, generally three attacks occurred daily. July 16th, 1871, the first injection of Curare was given. After the injection the patient felt slight symptoms of unconsciousness and dizziness until toward night he felt perfectly well.

No more epileptic attacks occurred after the first injection. Once every week I gave the patient an injection. After three weeks the prodromatic symptoms, indicating the coming attack, became prominent, but disappeared soon after the prompt injection of Curare. After I had, during the period of six weeks, used about 3 grs. of Curare, I omitted the injections, and until to-day (end of 1877) no more attacks have occurred.

Edgar, the younger brother, is now about 21 years of age, and is also not very strong. The first severe attack occurred March 21, 1870, the second in June, the third in November, 1870. The duration of the first attack was not quite an hour, with the second one the patient was unconscious from 4 P. M. until midnight. The attacks came on without the outcry, and commenced with the sensation as if a stream of cold air was flowing from the mouth. Between the large attacks small ones of a few minutes' duration always occurred. The first injection of Curare was given July 20th, 1871. From July 21st to July 25th there was some dizziness, and the patient felt as if an attack was coming on. This sensation, however, disappeared before long, and not a single attack occurred since that up to date (1877). The quantity of Curare used also amounted to 3 grs.; the injections were first given every week, afterward every second week.

Hugo Noack, in Halle, Y. S., suffered since infancy from convulsions, which first commenced when he was only ½-year old and returned about once in four weeks. No other member of the family ever had epilepsy. The attacks always were complete. As to the cause of this disease, the mother of the patient states that she once nursed the child shortly after a time of great anger. She says the attacks first made their appearance two hours later, and never disappeared since. The unfavorable influence of the disease on the patient's mental faculties was well defined during the age of school years; he did not learn well at all, and especially his memory was gone almost together. The attacks occurred so frequently that hardly a day or night passed by without convulsions. Noack came under my treatment in his 23d year. After from six to eight injections the convulsions disappeared, and since then, for about eight years, no attack has occurred. Noack is now 31 years of age, married, and is the father of two children, none of whom have suffered from convulsions up to this time. His mental faculties, and especially his memory, have greatly improved since his recovery. Noack is employed now on one of the large railroads, and fulfills his duties satisfactorily to his superiors.—*Translated* by PAUL H. KRETZSCHMAR, M. D., *in Hospital Gazette.*

TARTRATE OF LIME.

By A. SCHEURER-KESTNER.

TARTARS, lees, etc., are essentially composed of potassium bitartrate, with which calcium tartrate is often mixed. For the determination of the potassium bitartrate a standard alkaline liquid is generally caused to act upon a hot solution of the sample in water. But it has been found that this process leads to exaggerated results. Certain tartars, and especially certain lees, contain acid substances of the nature of tannin, which act upon litmus paper and consume the alkaline liquid just as potassium bitartrate would do. To obtain exact results it is therefore necessary to ignite the sample, and determine the potassium in the residue by means of standard acid. The determination of calcium tartrate is often made by dissolving the sample of tartar in hydrochloric acid, and precipitating with caustic soda. This method gives satisfactory results if the specimen to be analyzed is free from calcium sulphate. In the contrary case the numbers found are always erroneous, the error being proportionate to the quantity of gypsum present. It is known that calcium sulphate, in presence of an alkaline solution of a neutral tartrate, is converted into neutral calcium tartrate, while the alkaline base combines with the sulphuric acid. The reaction is so complete that in certain works it is used for the preparation of calcium tartrate for the formation of tartaric acid. At the moment when the hydrochloric solution of the tartar is neutralized, in order to precipitate the calcium tartrate, the most favorable conditions are obtained for the formation of this body at the expense of the calcium sulphate, and if there is gypsum in solution, as often happens, the quantity of calcium tartrate obtained by no means represents the amount actually present, but is augmented in equivalent proportions. Some authors have recommended the following process: Calcination of the tartrate to be analyzed, when the tartrates and bitartrates are converted into carbonates. The potassic carbonate is dissolved in water, and shows on titration the quantity of bitartrate originally present. The calcium carbonate remaining on the filter shows, in like manner, the value of the pre-existing calcium tartrate. But this process, though accurate when the tartar is free from gypsum, is otherwise defective. Hence the following method is to be preferred: The sample is dissolved in hydrochloric acid, and the filtered solution is neutralized with caustic soda, and then precipitated with calcium chloride. All the tartaric acid is precipitated as calcium tartrate. The precipitate is washed, calcined, and the calcium carbonate obtained is titrated in the ordinary manner. If the tartar has been previously titrated with a standard alkaline liquid it is easy, from these two data, to calculate the respective quantities of potassium bitartrate and calcium tartrate; but this is only possible when the sample is free from other acid products.

COLOR-COMPARATOR FOR QUANTITATIVE ANALYSES.

By ALBERT R. LEEDS, Ph.D.

THERE are numerous chemical operations in which it is required to estimate the amounts of substances in solution by the relative depth of tint of a certain color. Various methods of so doing have been resorted to, some involving considerable instrumental complication in the way of lenses, graduations, and rack and pinion movements. Without describing these particularly, it will be sufficient to say that the apparatus herein described was arranged with a view of dispensing with all lenses, or with graduations which could not be executed by the chemist himself. It was designed, moreover, to permit of the comparison of a large number of liquids at the same time, and in the same vessels in which the various operations upon them had been originally performed.

It is a rack, about 16 inches wide and of about the same height. The materials employed have been tin, sheet brass, or, in the latest and most perfect forms, of a combination of iron and brass castings. It is arranged to hold 10 comparison tubes, each of which, when filled to the same depth (6 inches), contains precisely 100 c.c. An adjustable mirror reflects the light downward through these comparison tubes, and the light, after passing through slits (¾ inch long and ¼ inch wide), cut in a stage beneath, is reflected outward to the eye by a similar adjustable mirror placed below. In the apparatus figured, the supports of the upper mirror are placed at the front corners, so as to make the axis of the mirror in front of the upper row of holes, and permit the tubes to be lowered into their places from the top. Later, it was found more convenient to slip the tubes in from below, which can be done without rising from one's seat, and in this case the axis of the mirror was put directly over the centers of the line of holes, and the mirror made somewhat narrower (3 inches). A black cloth, not shown, hung from the back upper corners, prevents any light reaching the eye except that reflected from the lower mirror.

The comparison is effected by a prism nearly filled with a suitable colored liquid. The prism is constructed by cementing within four straight walls of plate glass the inclined top and bottom sides of the prism. It is 10 inches long, 1½ inch wide, 2¾ inches at the base of the prism, narrowing to 3-16 inch at the apex. The prism is cut off in this manner at the apex, because, when filled with liquid of the most suitable intensity of color, the graduations beyond this point are too inconsiderable to be of value. The liquid is introduced through an orifice in the base, over which is afterward cemented a glass cover.

It would be of great service if a bottle-prism of about these dimensions were obtainable. This would permit of other than aqueous solutions being employed without detriment to the cement. And since it is desired to compare tints of color only, slight irregularities in the thickness of the walls of the prism would not seriously interfere with its use. In making the comparison, the prism may be either lifted to the right or left, directly upon the stage, or placed upon a second movable stage, which rests upon the former, and acts as a carriage. The prism is then moved out or in, until the requisite shade of color is arrived at.

Considerable difficulty is also experienced in purchasing comparison tubes of uniform diameter, so that when equal amounts of liquid are introduced they will be filled to the same height. It is hoped that comparison tubes with flat bottoms can be moulded, which will prove satisfactory.

EMPLOYMENT OF THE COMPARATOR IN THE ESTIMATION OF AMMONIA.

Some difficulty was experienced in finding a comparison liquid which would follow the tints given by the Nessler test, not only in very dilute but also in more concentrated solutions of ammonia. It was found that neutral ferric chloride, potassium sulphocyanide, and nickel chloride, in proper proportions, gave identical tints, but the solutions decomposed on keeping. After many trials, in which the chlorides of gold and platinum and other salts were employed, with the admixture of coloring matters, and of similar mixtures with infusions of tea, coffee, etc., we finally succeeded in obtaining with caramel solution and a small addition of aniline red a satisfactory comparison liquid.

Method of Comparison.—Above the prism, in the comparator, a comparison tube with about 20 c.c. distilled water is placed. The comparison liquid is made of such strength that the light, after traversing its greatest depth in the prism, shall give a tint corresponding to 10 centimilligrammes of ammonia. An application scale is prepared, once for all, by comparing the tints given by the prism with those given by known solutions of ammonia and the Nessler test, in 100 c.c. or 50 c.c. of distilled water placed in the comparison tubes. The readings are accurate within 0·005 milligramme of ammonia.

QUANTITATIVE ESTIMATION OF COLOR IN POTABLE WATERS.

The method ordinarily employed is to fill cylinders of a certain diameter and depth with the same volumes of the waters under examination, and then by description terms to describe the tints as compared with one another and with distilled water. But as a general rule these tints are not so far different from those which may be obtained by weak solutions of caramel, and these again from those imparted by the Nessler reagent to minute amounts of ammonia in solution, that a prism with a suitably arranged application scale may not be used in quantitatively estimating depth of tint in the color-comparator. Thus, on Dec. 4th, 1877, the color again given by 100 c.c. of Passaic water in one of the comparison tubes more nearly corresponded to that communicated by the prism when shoved in to a point equivalent to 0·075 mgrm. ammonia than to any other point on the scale, and this figure might therefore be taken as expressing the tint of the water at that date. If it were desirable to compare the tints of a large number of samples of water, and to express minute shades of color, it would be desirable to fill a wedge with a correspondingly dilute solution, and to graduate it by comparison with correspondingly minute amounts of ammonia.

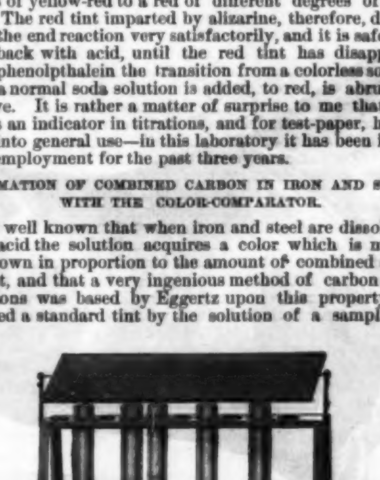
ALKALINITY OR ACIDITY OF POTABLE WATERS.

The color-comparator may likewise be employed advantageously to make a quantitative estimation of the degree of alkalinity or acidity of potable waters. This point, in the analysis of drinking waters, does not appear to have attracted much attention, probably because these waters are as a general rule so nearly neutral that they do not react alkaline or acid with the tests in general use. In the *American Chemist* for March, 1874, I have called attention to the great sensitiveness of an alcoholic solution of alizarine in this respect, and proposed to employ it as a means of comparing the alkalinity of drinking waters obtained from various sources. This may be done very rapidly by means of the color-comparator. One comparison tube is filled to the 100 c.c. mark with the water to be tested, and a second with water re-distilled until it has ceased to give any reaction for ammonia; 5 drops of alizarine solution are added to each, and then a centinormal soda solution run in, if, as is generally the case, the water reacts alkaline, until the liquid in both tubes has precisely the same tinge of red color. The amount of alkali added may be taken as an index of the total alkalinity communicated by the various saline bodies held in solution. Thus, on April 30th, 100 c.c. of the Passaic water, as drawn from the laboratory hydrant, acquired the same tint, when alizarine was added to it until the color no longer deepened, as 100 c.c. pure water to which the same amount of alizarine and 0·00068 grm. soda had been added. Of ordinary distilled water 100 c.c. was equivalent to 0·0003 grm. soda. This is not very far different from the amount which would be equivalent to the ammonia contained in ordinary distilled water, as determined by the Nessler reagent.

An attempt was made to substitute a solution of phenolpthalein for alizarine in these estimations. But there was no perceptible reddening when phenolpthalein, in amounts considerably greater than those which would correspond to the alizarine employed above, was added to similar samples. Phenolpthalein is far less sensitive than alizarine, and for such purposes is inapplicable. In titrating with alkali, however, it has an advantage over alizarine in the following respect. The latter changes very gradually through various shades of yellow-red to a red of different degrees of intensity. The red tint imparted by alizarine, therefore, does not mark the end reaction very satisfactorily, and it is safer to titrate back with acid, until the red tint has disappeared. With phenolpthalein the transition from a colorless solution, when a normal soda solution is added, to red, is abrupt and positive. It is rather a matter of surprise to me that alizarine as an indicator in titrations, and for test-paper, has not come into general use—in this laboratory it has been in constant employment for the past three years.

ESTIMATION OF COMBINED CARBON IN IRON AND STEEL, WITH THE COLOR-COMPARATOR.

It is well known that when iron and steel are dissolved in nitric acid the solution acquires a color which is more or less brown in proportion to the amount of combined carbon present, and that a very ingenious method of carbon determinations was based by Eggertz upon this property. He obtained a standard tint by the solution of a sample con-



taining a known amount of carbon, from which, by comparison of the depth of coloration, the percentages of carbon in other samples could be estimated.

His process has been variously modified, more especially by the substitution of a number of standard solutions, corresponding to various carbon percentages, in place of the one standard solution.* In this case, as the solution of the metal in acid does not preserve its tints for any length of time, the standard solutions are usually made of some coloring matter like caramel. A number of test-tubes are arranged in a convenient rack and filled with solutions, beginning with a color corresponding exactly with that produced by the solution of 1 grm. of iron containing 0·02 per cent. of combined carbon in 15 c.c. of nitric acid of sp. gr. 1·20, and ending with a color corresponding to a similar iron dissolved in like manner, but containing 0·30 per cent. of combined carbon.

Instead of a series of separate tubes, varying in color by an amount corresponding to 0·02 per cent. of carbon, it is proposed to use a prism, filled with solution of caramel, or, as Britton has proposed, with a solution obtained by digesting roasted coffee in dilute spirit, and of such strength as will represent every percentage between the points most frequently to be determined. 1 grm. of wrought iron or steel, in which the percentage of combined carbon has previously been determined with great accuracy, is digested with 15 c.c. dilute nitric acid at 80° for half an hour. The residue is gently heated over a lamp with 5 c.c. fresh acid, the solution added to the main portion, and filtered through a small asbestos filter. From the filtrate a series of solutions is prepared, each reaching to the 50 c.c. mark in the comparison-tubes, and each exactly half the strength as the one preceding. These tubes are then placed in the comparator, and the points on the prism which transmit identical tints of color are carefully noted, and transferred to an application-scale. 1 grm. of the sample to be analyzed is dissolved in like manner, the filtrate made up to 50 c.c. in the comparison-tube, and then the prism is moved out or in until it gives the same tint of color. The percentage, as marked on the application-scale corresponding to this point, is the percentage of carbon in the sample under analysis. If the percentage of carbon in the sample exceeds that indicated by the prism, a correspondingly less amount of the sample is to be brought into solution.

To illustrate the method the following details are given: A prism 10 ins. long, with a suitable caramel solution, was provided in the manner stated, with an application-scale graduated from 0·00 to 0·24 p. c. carbon. Upon a scale of this length the intermediate percentages could readily be obtained by interpolation. The graduation was not carried higher than 0·24 per cent., because larger amounts of combined carbon gave tints of color too deep to allow of slight differences in tint being recognized by the eye with certainty. A direct comparison with a series of steels, in which the amount of total carbon (Column II.) had been determined by combustion, gave the following results (Column I.):

	Column I.	Column II.
Sample I.	0·09	0·302
" II.	0·46	0·49
" III.	0·44	0·529
" IV.	0·62	0·640
" V.	0·72	0·801
" VI.	0·76	0·841
" VII.	0·80	0·867
" VIII.	0·86	0·87
" IX.	0·92	0·955
" X.	0·96	1·005
" XI.	1·04	1·058
" XII.	1·13	1·079

A great obstacle in executing analyses according to the methods above detailed is found in the difficulty of purchasing comparison-tubes uniform in shape, capacity and material. This difficulty having been brought to the notice of Messrs. Whitall & Tatum, 46 Barclay St., New York, they undertook to manufacture comparison-tubes not open to these objections. Moreover, their comparison-tubes being of uniform bore, and provided with a curved edge and lip for pouring, can be converted at once into graduates by the application of a linear scale, and being well annealed, can be used for tall precipitating glasses and a variety of other purposes. They have also undertaken to make the comparison-prisms, in the form of bottle-prisms, which will do away with the disadvantage of cemented joints. The comparators themselves have been cast in iron and brass, according to the designs of Mr. David Townsend, one of the students in the chemical department of the Institute, and will hereafter be made by Messrs. Hall & Benjamin, the instrument makers, of No. 191 Greenwich St., New York.

STEVENS INSTITUTE OF TECHNOLOGY, June, 1878.

* J. Blodget Britton, "Jour. Franklin Inst." [3], Vol. LIX., p. 356.

ON COLOR.

LORD RAYLEIGH, M. A., F.R.S., lately gave the first of a course of lectures on color at the Royal Institution, London. Referring to colored ribbons before him, his lordship explained that the retina of the eye is acted on by light and not by matter; and that, even when there is light, there may be no distinctions of color. Thus, with the monochromatic yellow flame of soda, he showed that colored ribbons became black. To understand color, therefore, light must be studied. Having produced a magnificent spectrum by prisms applied to the electric light, and thus demonstrated the composite character of light, he explained that all the various colors are due to different degrees of bending from the straight line (refrangibility)—red being the least and violet the most refrangible. No ray of the continuous spectrum thus produced, he said, can be further decomposed by a prism; it is homogeneous, but may be affected by polarization. Natural bodies possess the power of extinguishing or, as it is termed, absorbing the light that enters them. This power is selective. When the light falling on a body is wholly absorbed it is black; when it is equally absorbed, but not totally, it is gray; and when unequally absorbed, it is colored. The ray not absorbed is reflected. When all the rays of the spectrum are absorbed except blue, that is the color of the body—the color which it reflects. This was illustrated by a series of experiments with colored glasses and liquids, made with large prisms and the electric lamp, but which, his lordship explained, may be easily performed with small glass prisms and daylight. Thus a red object in the red rays of the spectrum retained its color, but became dark in the orange and green rays and black in the blue ray. In like manner other bodies retained their color in the corresponding rays of the spectrum, but lost it in other rays. His lordship showed that cobalt glass allows blue and red light to pass; a blue liquid cut off all but the blue, a red glass and blue liquid cut off all light, and a solution of litmus permitted the passage of red and blue. The spectrum apparatus thus affords the means of analyzing compound colors and ascertaining their components. The color of "Newton's rings" is not due to absorption, but to the differing thickness of a film of air between a lens and a plane surface of glass; and the color of ruled lines is due to diffraction, the action of the grating resembling that of a prism.

He commented on the opinion of Sir David Brewster, that monochromatic light not only stops certain rays of the solar spectrum but also modifies their color. This being incompatible with the wave theory of light, led to close investigation by Airy, Helmholtz, and other philosophers, who demonstrated that any such change of color must be attributed to imperfection in the prism, and that when the color of the ray is pure it cannot be further decomposed. Lord Rayleigh then showed by experiment the imperfection of visual testimony. The shadow of an object by green electric light appeared red when illuminated by gas light. He next explained the phenomena of fluorescence, as studied by Prof. Stokes, who proved that rays of light of such a high degree of refrangibility as to be beyond the violet end of the visible spectrum become visible when falling upon certain bodies, such as a solution of the disulphate of quinine. It was then shown how a very pure green may be obtained by cutting off two ends of the spectrum—the blue rays by means of a solution of bichromate of potash, and the red by means of a solution of sulphate of copper. The same result was obtained from a mixture of the two solutions. His lordship then explained a novel method by which he measured the varying degrees of absorption of different bodies. Two slits, backed by light of the same intensity, having been placed at the green part of the spectrum (for example), their spectra were so thrown on the screen that the green of the one should overlap the green of the other. When the lights of both slits were of equal intensity their brightness was equal; but when an absorbing medium was interposed between the prism and one of the slits a part of the light was held back, and to restore the brightness the slit had to be widened. Thus, by comparing the width of the two slits, a tolerably accurate measurement of the amount of the absorption is obtained. A curve showing the amount of absorption of chromium chloride was exhibited. The change of color due to various thicknesses of the absorbing medium, termed "dichromatism," was also shown; by chromium chloride, with a great thickness, blue glass became red. Colors, as seen by the eye, are rays which penetrate the colored body, and which are either seen directly or are reflected by the interior surface back to the eye. Thus, a solution of bichromate of potash in a black vessel had no color, as seen from the top, but became a bright red when a white plate was placed beneath the surface. The entering rays were thereby reflected back instead of being absorbed.

Exceptions were noticed to the rule which ascribes

the colors of bodies to absorption. For instance, the color of gold and other metals is due to reflection. The absorption of color also greatly depends upon the degree of thickness of the substance through which the light passes. The color reflected from a body almost opaque is complementary to its true color (*i. e.*, as green is to red); but if the light pass too far into the substance before it is reflected no color appears. Lord Rayleigh showed that crystals of the beautiful coal-tar dye magenta, which to the eye appear yellowish-green, become crimson by transmitted light. His lordship then proceeded to the consideration of compound colors, ingeniously illustrated by colored paper disks, sectors of which could be combined, the different colors being mixed by rotation of the disks placed upon a whirling-table, and thus rendered visible to the audience. For private experiments the disks may be revolved on a large pin. Many interesting results were thereby produced. The rotation of a disk half black and half white gave light-gray; increasing the black reduced the luminosity, the effect resembling that of diminished light. Various shades of any color were formed by adding black to it in different proportions, and various tints by adding white in a similar manner. This was specially demonstrated with the color red. A combination of black, yellow and white disks produced drab, and browns and drabs were shown to be darkened varieties of yellow, orange and red. Lord Rayleigh having ascertained by experiments the exact proportions of each color required to be placed upon the disk in order to procure certain varieties of shades and tints, recorded the figures and arranged them in a tabular form. This he exhibited, and he showed that by reference to it he was able to predict the results of certain combinations of color, and produce them at will. Thus, a combination of 67 parts red, 49 green and 50 blue gave the same gray as a combination of 34 white and 132 black. The result of a mixture of 23 green, 44 yellow, and 99 blue matched that of 118 black and 48 white. Among other combinations, it was shown that red and green will produce a match for black, yellow and white; and that a pink, the result of a mixture of red and yellow, may be matched by combining black, white and red.—*Illustrated London News.*

SEFTON, WINNER OF THE DERBY.

SEFTON.

THE trainer of the latest addition to the long list of Derby winners has certainly good reason to reflect on the enormous amount of luck connected with turf matters. Two of his most notable bids for the "blue ribbon" were made with Savernake and Pell Mell, each of whom was beaten a head, while Sefton, certainly 10 lbs. inferior to either of them, secured a clever victory. But Savernake and Pell Mell had the misfortune to respectively encounter a Lord Lyon and a Cremorne, while the twenty-one opposed to Sefton may fairly be described as "all wheelers." Sefton is a bay colt by Speculum—Liverpool's dam; and the mention of the sire makes us reflect once more on the son's luck. Both Speculum and Sefton won the City and Suburban; but while the former ran away from a grand field of horses, with 6 st. 12 lbs. on his back, the highest weight ever carried successfully by a three-year old, the latter won by a head, with the "feather" of 5 st. 8 lbs. Yet Speculum could only finish a bad third for the Derby, in which he had the misfortune to meet such giants as Blue Gown and King Alfred.

Sefton is a rather small horse, not standing much over fifteen hands two inches. He is not remarkable for power and substance, but has excellent shoulders, and legs and feet which are sound and well shaped enough to carry him through a very long career on the turf. He has plenty of length for his size, and is evidently a thorough stayer. He was bred at the Glasgow Stud, and at the annual sale at Doncaster in 1876, Mr. James Smith, who knew what a prize he possessed at that time in Rosebery, another son of Speculum, offered 950 guineas for him, but Mr. Craufurd, one of the most dashing bidders ever seen at a ring side, capped this with "a thousand," and became his possessor. The Hurstbourne Stakes at Stockbridge was selected for his *début*, and he did very fairly indeed, finishing only a length behind Redwing, and a neck in front of Attalus. Three more attempts last year did not enable him to earn a winning bracket, but on two of these occasions he met the flying Jannette.

This season he reappeared in the Craven Stakes at Newmarket, only to receive 5 lbs. and a half-length beating from Thurio. Still he did sufficiently well to draw marked attention to his City and Suburban claims, and he won that race by a head from Advance (8 st.), this being his first success. Pilgrimage and Insulaire proved too good for him in the Two Thousand; but in the month that intervened between the last-named event and the Derby, Taylor, his trainer, went to work in earnest, and sent him into the Epsom paddock in the perfection of condition, and a far better horse than he had ever been previously. He was ridden in the most finished style by Constable, who allowed him to stride along almost from the start, instead of fretting him by continually pulling at him, and, securing a nice inside berth at Tattenham Corner, he was never in danger of being caught.

Sefton is unfortunately omitted from the St. Leger entries, his forthcoming engagements comprising the following: The Prince of Wales' Stakes and Rous Memorial at Ascot, the Summer Cup at Newmarket July, and the St. Leger Stakes at the First October Meeting. In 1879 he is nominated for the Hardwicke Stakes at Ascot, and the Champion Stakes at Newmarket Second October.—*Illustrated London News.*

DYNAMITE IN AGRICULTURE.

IT is proposed to speak of the employment of dynamite for cleaning forests of stumps and roots after felling the trees, and for mellowing the subsoil and rocky substratum of arable land.

The first doubt will doubtless be on account of its danger. It is certain that dynamite must be used with care, as must all other explosives; it is also true that a spark which would explode gunpowder will only ignite dynamite harmlessly, and that a dynamite cartridge can be cut or broken rudely or hammered with a club without danger. It is only above 60° C. that a mass of it is dangerous; and many accidents have occurred by careless thawing and warming of dynamite which by reason of its affinity for water had absorbed that substance and been frozen. It is only necessary to guard against exposing small quantities of dynamite to friction between hard substances.

The remarkable advantage which dynamite has been to engineering science should embolden agricultural contractors to employ it in working large masses of timber, earth and rock.

In searching for a means of permeating the soil of the vine-districts with noxious gas to destroy the phylloxera, the idea of improving the texture of the soil by dynamite was "stumbled on." The advantage of giving the rootlets of the soil better opportunity to search for water and nourishment needs no argument. The cereals even have been known to plunge their rootlets into the soil where permitted and required, to a depth of 6 meters. The best subsoiling plow that we have cannot work much deeper than 24 to 27 ins., even with steam as a motive force; while 18 to 20 inches for ordinary subsoil plows is an excellent depth. It is certain that not only forest trees, the vine, etc., but even the ordinary sowed crops (especially those of the clover tribe), strike down much deeper. Plants like luzerne, which give several successive annual crops, owe this power to the deep-striking of their roots. As good roots make good stems, it is desirable to mellow the subsoil. A very simple cartridge will effect this to a surprising extent; and the question is: "Would it be possible by dynamite explosions to mellow the subsoil and substrata of arable land in a way favorable to agriculture?" and "If so, would it pay?" In the present article we shall occupy ourselves with the first consideration only.

In October, 1874, De Hamm experimented, at Kloster-Neuburg, on a diluvial clay, very compact, dry, viscous and deep, making holes two meters deep, in rows and groups. One group of 3 ranges, each with 6 holes, was charged with 266 grammes of dynamite (in cartridges) in each hole, and fired with an electric battery (Leonhardt machine). There was but little effect visible at the surface near the holes, but a disturbance showed about 12 meters therefrom, in the shape of furrows and fissures. Probing with a pick, beyond the range of explosion one could penetrate but 0·16 meter, while within it a depth of 1·32 meter could be reached.

A second set, fired by a Bickford exploder, gave poorer results; but a third, having cartridges of 333 grammes each, produced noticeable effects at 40 meters' distance, and carefully cutting down, the earth was shown to be affected to a depth of 2·50 meters, there being at the bottom of each mine a pear-shaped cavity, with hard walls. Tests with shallow wells, dug and filled with water, showed that after the explosion they lost their contents rapidly, forcing the opening of fissures in the soil.

A second set of experiments was made near Vienna on a field with a resistant calcareous substratum, and the mines were pierced slanting, having 0·60 meter slant and a depth of 1·66 meter. Ten mines 2·66 apart were charged each with 260 grammes of dynamite. Although satisfactory, these experiments did not go to show any advantage over the easier mode with vertical holes.

Experiments on a large scale were undertaken at Dobris, in Bohemia, in August, 1876. There were proposed three things: first, to remove a bank of rock which prevented culture; second, to render arable an unplowable, rocky bottom; third, to mellow the subsoil and substratum of another part where the surface was not troublesome.

The rocky masses were of clayey schist, in beds having angles in every direction, partially decomposing and scaling at the surface, but compact at the bottom. The largest was 10 x 5 meters above the surface of the ground, and was evidently a truncated cone having a large base below the surface. To operate with more surety, two test mines were drilled—one by hand in the most weathered portion, and 45 centimeters deep; the other by machine in the most solid part, 56 centimeters deep; the first charged with 72 grammes, the second with 100 grammes. The effect was good. For a distance equal to twice the depth of the holes the rock was so broken up that there was not a piece left larger than a walnut down to a depth of 65 to 75 centimeters. Then other mines were worked, charged with from 300 to 500 grms., with surprising success, the rocky masses being pulverized 1·86 meter deep, so as to be plowable.

The second test at Dobris was on a tract of 4,000 square meters, admirably calculated for a cemetery if it were not for a rocky bed which underlay a very thin layer of earth. Four mines 5½ meters apart were charged with 667 grms. each; the explosion was feeble in sound, but threw up a cone 18 meters in diameter; and the sphere separating, each of the mines had 3½ meters height above the surface. One mine was fired with 1·67 kilogramme of dynamite; the sphere affected had a radius of 8·40 meters, and the cone formed was not less than 10 meters across.

Inspection ditches were then dug, 5 meters deep, and it was seen that while those mines fired by the electric battery had operated to a depth of 4½ meters, those hand-fused had acted to a depth of 3 meters only.

In the third Dobris experiment there was very firm surface soil over a very homogeneous and compact ochery clay subsoil. The surface was a crust so hard as to be unplowable. By pick and mallet, holes were made 1·60 meter apart and 1 meter deep, each charged with 700 grammes of No. 4 dynamite, and fired by a Bickford apparatus. The tract, 98 meters square and having 32 mines, was furrowed and torn deeply in all directions, and while the hard-baked crust was not completely pulverized, it was at least plowable.

Further experiments were made at Atzgersdorf, near Vienna, there being a rather thin arable layer of "potter's clay," below this decaying calcareous and sandy substances, and a lower bed of viscous and compact clay. This was a difficult field to cultivate.

Three groups of mines were made, one 1·75 deep and from 2·50 to 3 meters apart; another set 1 meter deep and 1·50 to 1·75 meter apart; a third from 1·50 to 2 meters deep. The two first were fired with a battery and the others with a Bickford exploder. Where the soil was calcareous and sandy the explosions made a dull noise; in the arable bed there were stronger detonations. A plow was run deep through the scene of the explosions with great ease.

Altogether we could see that the explosion of dynamite did not produce a uniform effect, depending on the mode of ignition, etc.

Another set of experiments was made on a stony patch sowed with trefoil, giving a cone with a central crater, while the "top crust" of the field was lifted up and torn. But the curious part of it was that when it came to level off again, the earth in the hills would not suffice to fill up the hollows and crevices.

This was occasioned by an absolute compression of the walls of the cavity surrounding the explosion, they being hard as if cemented; and this was found in every case where the ground was not essentially stony.

It was thus found that dynamite could in some cases be hurtful (1) by destroying the roots of plants, and (2) by causing instead of a loosening an absolute local compression where the soil was moist and elastic.

Mr. Fichtner thought that this last might be perhaps an advantage by aerating the lower stratum and permitting the introduction of manure therein. He had proved 20 years before that the temperature of subterranean cavities was not subject to the variations noted in the outer air, and was 16° C. higher in winter than that of the outer atmosphere. Thus the dynamite cavities might prove useful as moderators of temperature, and it was noticed that the snow actually melted more rapidly over them than elsewhere.

Concerning the fertilizing, he filled 96 exploded mines with a mixture of 75 per cent. sand and 25 per cent. of bone dust, lime, sulphate of ammonia, potash, magnesia, nitrate of soda, plaster and superphosphate. [Some of his researches on the influence of electricity on plant growth had satisfied him that vegetation was stimulated by the electricity developed during chemical charges, and he conceived the idea of placing in alternate holes metal plates connected with wires above the soil so that the current must travel through the intervening soil. These experiments are not yet concluded or published.]

Dr. Edward Lucas proposed dynamite as a mode of making trenches or holes to receive young trees or plants. Experiments tried at Dobris and at Breitensee (near Vienna) showed that a very hard and dry soil could be made ready by dynamite for trenching by the plow. Mines were made 1·25 meter deep and charged with 207 grammes of dynamite exploded by a Bickford apparatus. The marked breaking up was throughout a radius of 1 meter; but effects were noticeable throughout 2·1 meters radius. It has been proposed to mellow the soil between trees in orchards with dynamite, but this would doubtless damage the roots.

As regards dynamite in draining, it is well known that "side drains" along the main channels are very expensive, and it was proposed to employ dynamite to effect the side drainage or "feeding." The manager of the Archduke Albrecht's estates at Teschen, Mr. Walcher-Uysdael, made experiments in a light soil, with less good effect than expected, but still with encouraging results, showing that experiment would yield excellent success.

Concerning dynamite in trenching for surface drainage, in general constructive engineering, quarrying, iron founding, etc., there is much yet to be done.

GARDENS.

By Peter Henderson.

Next to the gardener proper, no class of men can more easily supply themselves with fruits and vegetables than the farmer; he has the land, horses, and usually all the implements needed in the cultivation of the soil, and his knowledge of farm crops makes it easy to acquire the different details needed for the culture of the garden.

This fact is broadly apparent when we know that a majority of the market gardeners of New Jersey and Long Island were originally farmers, and that comparatively few of them were regularly trained to the business of gardening in their youth. Yet in view of all this, we find that very few farmers living away from our large cities cultivate either fruits or vegetables, and their tables are far less bountifully supplied with these than the day laborer of the city, who supplies himself from the abundance of our markets even with such luxuries from his dollar a day.

There is yet somewhat of an idea prevalent even among farmers that the products of the garden require a soil different from that of the farm; this is a delusion—any soil that will grow good crops of corn, hay, wheat, and potatoes will grow good crops of almost any variety of fruits or vegetables, only, of course, the higher the cultivation will be in either case the more satisfactory will be the crop.

What the extent of a farmer's garden should be must be decided by his wants or means of culture, though it may be laid down, as a general rule, that one-fourth of an acre, or a space of 100 feet by 100, would be ample for the requirements of any ordinary-sized family.

For convenience the kitchen garden should be near the dwelling, and if appearances enter anything into consideration, it would be better placed at the rear than the front of the house.

When there is room to use the plow and harrow in preparing the ground for the garden crop, these will always do the work more thoroughly than the spade; even in preparing the ground for our most delicate flowering plants we always use the plow in preference to the spade when it is practicable to do so.

What kinds of vegetables and fruits to plant and the space to be allowed to each will come next in order. In vegetables, asparagus is a very important crop, and, when once properly planted, will take care of itself, if the weeds are kept off, for 20 years. This proper planting consists, first, in having the soil deeply plowed and subsoiled to a depth of at least 18 inches, and thoroughly enriched with manure, and in having good healthy plants set out at about 12 inches each way—a space of 6 feet by 30 requiring 300 plants. It takes two years usually from time of planting for asparagus to yield a full crop, but when once in full bearing a bed of the size named will give an unfailing supply.

Rhubarb, like asparagus, gives a crop many years without renewal; a dozen plants, set 2 feet apart, will suffice. The general crop of vegetables are mostly grown from seeds; the detail of the quantities of these are so much a matter of taste that it need not be entered into. I will briefly say that an assortment, embracing peas, beans, beets, onions, radishes, etc., will, costing from $3 to $4 duly apportioned, be sufficient.

Such vegetables as cauliflower, cabbage, lettuce, tomato, or egg plants had better be set out in plants, and if they can be purchased in the vicinity where wanted all the better, as they are too tender to transport far—100 each of cauliflower, cabbage, and lettuce would be enough, while two dozen tomato plants and a dozen of egg plants would produce all that is likely to be needed. Any special details for culture would be unnecessary when the books on the subject are now so easily procurable.

In small fruits, perhaps generally appreciated are grapes. If the ground allotted to the garden is fenced (which it should be), the fences can be used to great advantage in training the grape vines. Wire or wooden slats should be placed 6 or 8 inches from the fence so as to admit air. Grape vines so trained having a south or southeast aspect will mature crops earlier and will generally be more certain to bear than if not so sheltered; besides, when trained against the fences, but little ground space is taken up. 12 or 15 grape vines, comprising, say, 6 or 8 sorts, when in full bearing, will give a large supply. The varieties are now so numerous, and are yet yearly improving, that it is hazardous to recommend what are the best; besides, it is so much a matter of individual opinion that it is rare that any two cultivators agree on what could be recommended as the best half dozen sorts. I fruit some 20 sorts, and from these would name as the best for general cultivation, Concord, Delaware, Iona, and the Rogers hybrids, Nos. 15, 22, 41, and 44; these comprise nearly all shades of color, extending in their period of ripening in the latitude of New York from the first of September through October.

Strawberries come next in importance among the small fruits. A bed of the size recommended for asparagus, and requiring nearly the same number of plants, would be ample for all the requirements of an ordinary family. The product from such a bed, under fair cultivation, would be, at a low estimate, 100 quarts, which would be from 4 to 6 quarts a day during the season. Though strawberries will bear fair crops for two or three years if properly trimmed and top-dressed with manure, I am one of those who believe that the finest fruit, if not the heaviest crops, can be best got by planting each year. By what is termed the layering method a full crop can be obtained in nearly ten months—that is, plants set in August, if properly handled, give a full crop in June. As this method has recently been extensively published in the leading agricultural journals, and also in books specially devoted to gardening, there is no need to detail the plan here.

The varieties of strawberries, like grapes, are now very numerous, but for general cultivation no one would go far astray in planting either "Monarch of the West," "Charles Downing," "Seth Boyden," "Beauty," "Triomphe de Gand," or "Great American," or the whole of them. Raspberries and blackberries follow strawberries; about the same area, 50 feet by 6, may be allotted to each, though the distance apart at which they should be planted is wider, of course, namely, 2 feet by 3. The new raspberry, "Pride of the Hudson" (red), "Caroline" (yellow), and "New Rochelle" (purple), bid fair to supersede the older varieties of the same color. In blackberries, Wilson's "Kittatinny" and "cut-leaved" ought all to be grown if the full season of fruiting is desired, as they comprise the earliest and latest sorts in the order named.

In currants 25 red, 12 white, and 12 black would be about the proper number, planted 2 feet by 3. In gooseberries the only kinds that do well here are our American varieties, known as "Downings," a greenish white, and "Houghton's Seedlings" (red); they are of medium size and fair flavor; a few of these may be grown, but they are not generally very satisfactory.

Americans visiting Europe are astonished when they see the great variety and immense size of the gooseberries grown there, for in England it is one of the finest of small fruits, and our travelers buy thousands of the bushes from the English nurserymen and send them here every season, which rarely fails to result in disappointment, for these English varieties are all but worthless when grown in our hot and arid summers.

No more profitable study can be engaged in by agriculturists than that of the influence of climate on vegetation, a more thorough knowledge of which would prevent many such blunders. I once heard of an Englishman who, on returning from a summer trip to the United States, and who had been delighted with what he had seen of the products of our tropical summer, concluded he would astonish his neighbors by the crops of maize, melons, etc., that he would produce on his Yorkshire farms, but he was doomed to disappointment. His melon seeds rotted in the ground, and there was not sufficient warmth in his Yorkshire climate to grow his corn crop a foot high. On the other hand, we have Scotch and English farmers coming here every year by the score who are forced to learn that oat or turnip crop will not respond as they did in the lower temperature and moister atmosphere of their native country. But this is a digression.

Many farmers have their apple orchards; but pears, cherries, peaches, and plums are not so common; all these are now so easily procurable and cheap that, though they may not always do well, a dozen or so of each class would be well worth planting. In nearly all cases where fruit trees are to be purchased the farmer should buy from the nurseryman nearest to him in preference to buying from agents, and if he is such on whom he can rely it is much better to allow him to make the selection of kinds than to make it himself; most nurserymen grow the greater part of their stock of the leading kind, and their selection is almost certain to be better than that of the buyer, which in most cases is made only from descriptions given in catalogues. As it takes years before most fruit trees come into bearing, it is all important that the best kinds only are planted, and the greatest caution should be exercised in making such purchases. Most of those interested in grapes will remember that, when the Delaware was introduced, plants no larger than knitting-needles were sold at $5 apiece by Dr. Grant, of Iona, and others. About that time a tree agent came along one day and sold one of my neighbors five vines, each twenty times the size of Dr. Grant's, for $3 apiece—warranted Delaware. These vines have borne fruit now for a dozen years, but so far not a bunch of Delaware—they were all Concords. My neighbor is rather an irascible gentleman, and ever since it has been most unfortunate for any tree peddler who stumbles into his domain.

Does the farmer's garden need flowers? I know that his wife or daughters will say so. What they should be I will not venture to name, for the variety now is legion, and, as descriptive and illustrated catalogues, both of seeds and plants, are now sent everywhere, selections can be made to suit the circumstances or taste of all. In the matter of seeds and plants the mail affords great facilities, so that the residents of our Western frontier, a thousand miles away, can get his supply of seeds and plants just as cheaply and safely as if there was a green-house or a seed store next door.

Independent of the pleasure that the farmer may derive from his garden of fruits, vegetables, or flowers, there is no doubt that in many cases it leads to a business far more profitable than his crops of the farm. In our growing country towns and villages spring into existence where a decade before was only an unpeopled waste, and the shopkeeper, mechanic, or artisan is glad to buy the surplus the farmer may have from his overflowing garden.

FODDER CORN.

On dairy farms, corn, planted specially for feeding green in summer and early fall, is becoming almost a staple crop, and as indispensable as the crop of potatoes, beans, and corn for grain. It makes such a heavy growth, is so well adapted to land comparatively dry, and does so much better in dry weather than most grasses, that its cultivation for feeding green will probably increase rather than diminish. Many farmers, who formerly grew but a few rows, now raise it by the acre, and feed it daily from July to September. By growing fodder corn plentifully, farmers are enabled to keep their stock off from their mowing fields in early autumn, and for this object alone it will pay well to grow corn in abundance. If there is any operation on the farm like killing the hen that lays the golden egg, it is the practice of turning a drove of hungry cows into a mowing field the next day after the hay is gathered and keeping them there till the ground freezes. The deserted farms in New England, which we hear so much of through the newspapers, have been brought into their present dilapidated condition largely through this custom of fall feeding mowings.

The grass is gnawed down and pulled up just when it most needs to be let alone; just when the hot and burning sun is most severe on the roots; just when it is the least able to bear over-feeding. If farmers would more generally than they do grow corn to help out the supply of feed for their cows in summer, they could, after a time, dispense entirely with after-feeding their mowing fields, and when that time comes they will need very few fences, except those around their permanent pasture lands. These two items, the maintaining of fences around tillage fields and division fences between mowing and tillage lands, and the injury done to mowings by over-feeding them in the fall, are of sufficient importance to set every thinking, economical farmer trying to devise some method for avoiding such expense and damage, and we know of no move one can make toward a better system so advisable as to plant a liberal breadth to fodder corn. For very early use, the first planting should have been put in last month or early in the present, but planted now, or even one or two weeks later, good crops can be obtained. We never hesitate to plant as late as the fourth of July, and have had fair crops planted as late as the tenth. For very early planting, we have preferred the western or southern flat, as it starts off stronger in the spring and will be fit to cut a little earlier than the sweet varieties, which grow rather slowly the first few weeks. But for the main crops sweet corn is much to be preferred, as it is eaten with much better relish by cattle.

It was formerly customary to plant a great amount of seed per acre, so that the stalks should be small, but corn planted excessively thick is not as good for feeding, except when very young, nor is it apt to stand up till fully grown, but lodges under strong winds or heavy showers, and thus becomes anything but good wholesome food for cows. To have corn-stalks or leaves make good fodder, they must have a fair amount of sunlight to grow in. Lodged corn not only loses the sunlight, but it often rots badly on the ground. The seed should be planted thin enough so that the stalks will stand up in ordinary summer weather, then the juices will be sweet and rich. One bushel of medium-sized seed we find ample quantity for an acre, and even less will give a very heavy crop on good rich land.

The Stowell's Evergreen has been one of the most popular varieties of sweet corn for growing fodder, but if it were slightly reduced in size by mixing with a smaller variety, it would be none the worse. An eight-foot stalk is quite as good for feeding as one that is ten or twelve feet high.

In raising any crop for feeding green in summer, it is always safe to lay out for all that may be required in case of a poor season; then, if more is grown than is needed for feeding green, it can be cured for winter use. But it must always be remembered that all forage crops should be cut before they are out of bloom. Corn is no exception to this rule. When it comes in bloom, if there is a surplus above present demands, it should be cut and stooked in the field as corn for grain is stooked, then it will make good fodder for late fall or winter. A few bunches of such fodder partially cured are very handy to have on hand in the barn for feeding on rainy days in summer and fall when it is too wet to handle green corn with comfort. One objection to planting sweet corn, and a serious one, too, has been the high price asked in market for the seed in years past. With seed at four or five dollars per bushel, and the belief that two or three bushels are needed per acre, farmers cannot be expected to plant the sweet varieties very extensively, when sound Western corn can be bought for sixty or seventy cents per bushel. Sweet corn for fodder has been selling in this market this season at about two dollars per bushel, and unless the demand increases beyond present expectations it will not be much higher.

It is not difficult to ripen the seed, and every farmer, by a little care at the right time, could easily raise and cure enough for an acre or two each year. The main point in curing the seed is to dry it quickly after it is fully grown. Exposure to long storms in the field, or to frosts before it is thoroughly dry, is pretty sure to spoil it for planting. There is no better way to dry it on a small scale than in traces hung in an open, airy shed.—*N. E. Farmer.*

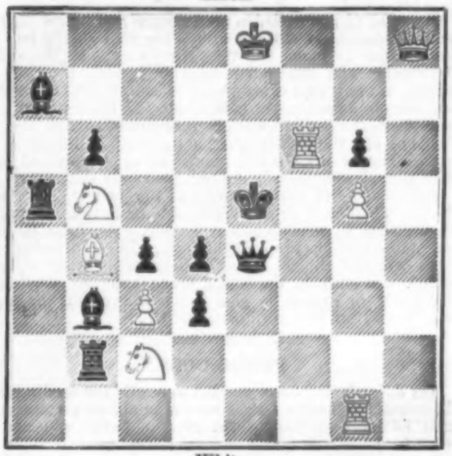
SCIENTIFIC AMERICAN CHESS RECORD.

[All contributions intended for this department may be addressed to SAMUEL LOYD, Elizabeth, N. J.]

PROBLEM No. 100. BY SAMUEL LOYD.

Prize for the best problem of the Charleston *Courier* Tournament of 1859.

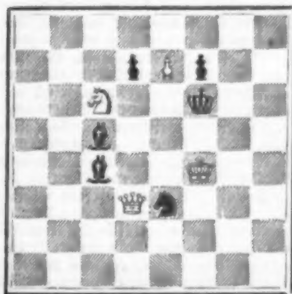
Black.



White.

White to play and mate in three moves.

JOSEPH ALONZO POTTER, OF SALEM, MASS.



White to play and mate in 2 moves.
By W. A. KANE, of the Winsted *News*.

ONSIDERING the limited number of his compositions and the short time devoted to the art, few problemists have enjoyed such a wide-spread popularity as the subject of our present sketch.

In all he composed but fifty problems, and was known in the chess world but a little over two years, yet he was reckoned as one of the most pleasing problemists of the day.

Mr. Potter was born in Salem, on the 29th of December, 1837, being named after his distinguished relative, Bishop Joseph Alonzo Potter. He was an invalid from an early age, being afflicted with the spine disease to such a degree as to be scarcely able to walk. He commenced to compose problems in the fall of 1856, and assumed charge of the chess department in the Boston *American Union* in 1858, which he conducted with marked ability until the time of his death, in the spring of 1859.

He was always cheerful, and wrote the most charming and witty letters, which endeared him to a host of admiring friends. He was an able critic and skillful solver.

Some of his compositions are quite elaborate, but his peculiar style is better represented by his more simple stratagems, of which the following are specimens:

ENIGMA No. 70.—BY J. A. POTTER.

White.—K on Q B 4, R on Q 3, Kt Q B 3.
Black.—K Q R 6.
White to play and mate in three moves.

ENIGMA No. 71.—BY J. A. POTTER.

White.—K on K 6, Q K R 3, Bs Q Kt 7 and K Kt 7, Kt Q R 4.
Black.—K on Q Kt 4, Ps Q R 4, Q Kt 5, Q B 5 and K 2.
White to play and mate in three moves.

CHARLESTON COURIER PROBLEM TOURNAMENT OF 1859.

DURING the spring of 1859 the proprietors of the Charleston *Courier* issued the programme for a grand problem tournament, and through their chess editor, P. A. Aveilhe, Jr., offered three valuable prizes for the best sets of three original problems, of from two to four moves. For the first prize, a splendid set of ivory chess men and board, of the value of fifty dollars.

Second prize, a board and men of the value of forty dollars.

Third prize, a board and men of the value of thirty dollars.

Fourth prize, for the best single problem of the tournament, a gold medal suitably inscribed, of the value of twenty-five dollars.

On the 25th of January, 1860, the committee of award, consisting of Messrs. L. Avery, E. A. Balagnor, and J. Palma, three well-known experts, awarded the gold medal for the best problem of the tournament to Samuel Loyd.

The prize for best set, to a joint set of problems, contributed by J. P. Barnett and Samuel Loyd, which were inscribed to the memory of Joseph A. Potter, who had recently died.

Prize for second best set to G. N. Cheney.

Third prize to John P. Swan, of Detroit, Mich.

Strange to say, owing to the discontinuance of the chess column of the Charleston *Courier* before the publication of the problems, and the non-appearance of the tournament book that was afterward promised, it is impossible to give a complete record of this tournament.

The war broke out shortly after and interrupted communications, and although most of the participants took active part in the little "unpleasantness," and hot shot and shell were showered upon the *Courier* office from the Union lines, neither the boards nor the medal were ever surrendered, and remain unpaid to the present moment.

There is even considerable difficulty in ascertaining which were the winning problems. The three-mover to which was awarded the highest honor was published, and we find a four-mover in our collection marked Charleston *Courier* Tournament, but Mr. Barnett, who was our partner in that prize set, remembers nothing about it, and the other prize bearers, as well as the members of the editorial staff, have been dead these many years.

The competition was very large, and embraced contributions from the leading American and European composers, and were highly eulogized by the committee of award; and we are sorry to be unable to give a more complete report.

THE ASSOCIATION LETTER TOURNAMENT.

THIS contest, the particulars of which will be found in SUPPLEMENT No. 101, is now closed, and the entire collection (of which there are ten problems received) are placed in the hands of Mr. Charles A. Gilberg, of Brooklyn, who has kindly consented to act as umpire. In addition to the beautiful prize offered by Dr. Moore, we will present to the authors of the three best problems the complete volume of the SUPPLEMENT Chess Department, and a bound volume of Mr. Hallock's series of the *Chess Journal*.

The following fantasia from the *Globe-Democrat*, representing the letters G D, complete the entire collection of the letter problems: The award will be given next week.

ENIGMA "G D."—ASSOCIATION LETTER TOURNEY.

White.—K on Q Kt 3, Q Q R 4, R Q 4, B Q B 4, Ps K 3, K B 3, K Kt 3, K R 4 and 5.
Black.—K K B 4, R Q R 5, Kts Q B 6 and K Kt 3, Ps Q Kt 3, Q B 3, K 3, K B 3 and 5.
White to play and mate in four moves.

JOSEPH ALONZO POTTER, OF SALEM, MASS.

SOLUTIONS TO PROBLEMS.

No. 94.—BY G. N. CHENEY.

WHITE	BLACK.
1. Q to R 8	1. R x Q
2. R x B	2. R checks
3. R to K sq mate.	
	1. B x B
2. R to Q 6 ch	2. R or P x R
3. Q to R sq or Q R 8 mate.	

No. 95.—BY J H. MORRISON.

WHITE.	BLACK.
1 B to K B 6	1. K x Kt
2. Kt to Q 7 ch	2. K to Q 4
3. B x B P ch	3. K moves
4. P x R (Kt) mate.	
	1. K to Kt 7
2. Kt to Q 3 ch	2. K to Kt 8
3. B to B 2 ch	3. K moves
4. Mates.	
	1. Kt to K Kt 6
2. Kt x Q B P	2. K to Q 6
3. Kt to K 5 ch	3. K moves
4. Mates.	

LETTER "P."—ASSOCIATION TOURNEY.

WHITE.	BLACK.
1. B x R	1. K to B 3
2. Kt to Kt 8 ch	2. K moves
3. Mates.	
	1. K to K 3
2. Q to B 4 ch	2. K x Kt
3 Mates.	

No. 96.—BY SAMUEL LOYD.

WHITE.	BLACK.
1. R to K B 5	1. R x B
2. Kt to K Kt 5 dis mate.	

No. 97.—BY SAMUEL LOYD.

Our space will only permit us to give the leading variations.

WHITE.	BLACK.
1. Q to B 8	1. K to B 5
2. Kt x P	2. K x P
3. Kt x P	3. K moves
4. Q mates	
	1. P to R 6
2. Kt x P	2. K to R 7
3. Kt x P ch	3. K to R 8
4. Kt to B 2 mate.	
	1. K x B
2. Kt to B 2 dis ch	2. K moves
3. Q to R 3 ch	3. K moves
4. Q mates.	
	1. K to R 5
2. Kt x P	2. K to Kt 4
3. Q to B 5 ch	3. K moves
4. Q mates.	

LETTER "C."—ASSOCIATION TOURNEY.

WHITE.	BLACK.
1. Q to K R sq	1. K moves
2. Q to Q R 8	2. Moves
3. Mates.	

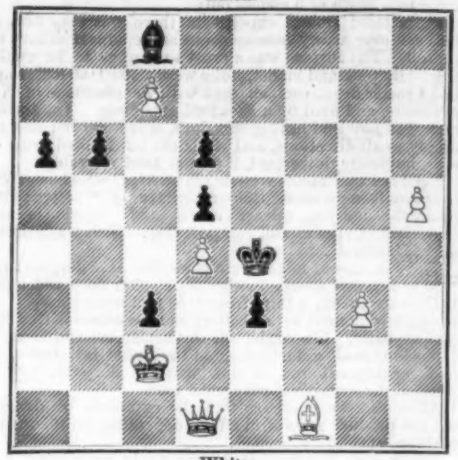
ENIGMA No. 61.—BY SAMUEL LOYD.

WHITE.	BLACK.
1. Kt to Kt 3	1. Kt to Kt 3
2. Kt to Q 4	2. Any
3. Kt x P mate.	
	1. P to B 4
2. R to Kt 5 ch	2. Any
3. Mates.	
	1. K to R 6
2. Q to Q B 3	2. Any
3. Kt to B sq mate.	
	1. P x Kt
2. Q to Q 2 ch	2. K to B 5
3. B to K 6 mate.	

PROBLEM No. 101. BY SAMUEL LOYD.

From the Charleston *Courier* Tournament of 1859.

Black.



White.

White to play and mate in four moves.

ENIGMA No. 62.—BY W. A. SHINKMAN.

WHITE.	BLACK.
1. Kt to B sq	1. Any move
2. Kt dis ch	2. K moves
3. Kt mates.	

ENIGMA No. 63.—BY DR. C. C. MOORE.

WHITE.	BLACK.
1. K to Kt 5	1. K to B 5
2. K to B 4	2. K to K 4
3. R to B 7	3. K to K 3
4. K to Q 4 mate.	
	1. K to Q 5 or 6
2. R to K 7	2. K moves
3. R to K 2	3. K moves
4. Q to B 4 mate.	
	1. K to K 5
2. R to B 4	2. K to B 6
3. R to Q 4	3. K to B 5
4. Q to B 4 mate.	

ENIGMA No. 64.—FROM ENGLAND.

WHITE.	BLACK.
1. R to Q R 7	1. K x P
2. R to Q R 5	2. Any
3. Kt x Q P	3. Any
4. B mates.	

ENIGMA No. 65.—BY X. HAWKINS.

WHITE.	BLACK.
1. Q to K B 5	1. P to K 3
2. Q to K B 8 ch	2. K moves
3. Mates.	
	1. K to B 4
2. Kt to Q 3 ch	2. K moves
3. Q mates.	

PROBLEM SOLVING.

J. A. POTTER, while chess editor of the *American Union*, in speaking of problem solving, said:

"In solving a problem, you should not, after studying an hour or so, give it up and look at the solution, but set it aside for your leisure and try again.

"Attempt the end, and never stand to doubt,
Nothing so hard but search will find it out."

"We wish our correspondents to derive pleasure and instruction from discovering solutions; looking at the printed ones is hardly the fair thing."

Lewis says:

"Problems should be solved from the diagrams. There can be no doubt that those who discover the method of winning from the diagram alone, are entitled to the praise of having fairly solved the position; but the like praise cannot be given to those who, placing the pieces on the board, try first this, then that move, until they have hit the right one."

CAXTON'S "GAME OF CHESSE."

THE first book printed in the English language was "The Game of Chesse," published by Caxton. A copy once sold for $650.

It was originally written by Jacobus de Coefollis, a Dominican friar, before A. D. 1200. Dr. Hyde says it was a moral book, entitled "De Moribus Homininum and Offius Vablium," and was translated into German verse by Conrad Ammenbusen, a monk of Settin, in 1337. Verci says that the original work was written either in French or Latin, and that the Latin manuscript is still preserved in the library of the seminary in Padua. The first Italian edition was printed at Florence in 1493, in quarto, the second at Venice, fourteen years later, in octavo, with common Roman type, and is ornamented with thirteen prints from wood engravings. The outlines only are expressed, without shade, and are tolerably drawn. The frontispiece represents two men playing at chess, a king is seated on his throne, and four other spectators standing by watching the game.

CONCLUSION.

WITH the present issue we conclude the first series of the SCIENTIFIC AMERICAN Chess Record. All the numbers containing the problems we have published, which form by far the most complete and comprehensive Chess Record ever published, may be had collectively or separately at the SCIENTIFIC AMERICAN Office, 37 Park Row, New York. We intend hereafter to publish them in a separate volume, the issue of which and price will be duly announced.